Annexure A1

Item No: 01

Bachelor Program in Mathematics

Degree Awarded: BS-Mathematics

Entrance Requirements: HSC (Pre-Engineering Group) or equivalent with at least 45% marks

Duration of the Program: 4 years (8 Semesters)

Total Credit Hours: 136
Total Marks: 4500

Marks Breakdown for Courses

Item	Maximum Marks for Courses (without Laboratory)	Maximum Marks for Courses with Laboratory (2 + 1)
Mid-Term Examination	30%	15%
Internal Marks (Assignments, Quizzes, Presentations)	20%	20%
Laboratory	----	15%
Semester Examination	50%	50%
Total	100%	100%

The BS Scheme of Studies: Main Structure

S. No.	Categories	Number of Courses	Credit Hours
1	Compulsory Requirements	08	22
2	General Courses	10	30
3	Discipline-Specific-Foundation Courses	10	30
4	Major Courses	09	27
5	Electives Courses + Project	09	27
Total		**46**	**136**

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The BS Scheme of studies: Layout/Framework

Compulsory Courses		General Courses	
Title	Credit hours	Title	Credit hours
1. Islamic Studies	2	1. Mechanics	3
2. Pakistan Studies	2	2. Waves & Oscillations	3
3. English Structure	3	3. Electromagnetic Theory	3
4. Communication Skills	3	4. Modern Physics	3
5. Technical Writing	3	5. Introduction to Economics	3
6. Introduction to computer	3	6. Econometrics	3
7. Programming Languages C/C++	3	7. Introduction to Accounting	3
8. Computing Tools	3	8. Business Mathematics	3
		9. Introduction to Psychology	3
		10. Introduction to Sociology	3
Total	22		30

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Foundation Courses		Major Courses		Electives Courses+ Project	
Title	**Credit hours**	**Title**	**Credit hours**	**Title**	**Credit hours**
1. Calculus-I	**3**	**1.** Discrete Structures	**3**	**1.** Elective-I	**3**
2. Calculus-II	**3**	**2.** Number Theory	**3**	**2.** Elective-II	**3**
3. Calculus-III	**3**	**3.** Probability Theory	**3**	**3.** Elective-III	**3**
4. Algebra-I	**3**	**4.** Vector & Tensor Analysis	**3**	**4.** Elective-IV	**3**
5. Algebra-II	**3**	**5.** Classical Mechanics	**3**	**5.** Elective-V	**3**
6. Algebra-III	**3**	**6.** Basics Topology	**3**	**6.** Elective-VI	**3**
7. Complex Analysis	**3**	**7.** Mathematical Statistics	**3**	**7.** Elective-VII	**3**
8. Ordinary Differential Equations	**3**	**8.** Numerical Analysis	**3**	**8.** Elective-VIII	**3**
9. Real Analysis-I	**3**	**9.** Partial Differential Equations	**3**	**9.** Project/Elective-IX	**3**
10. Real Analysis-II	**3**				
Total	**30**		**27**		**27**

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SECHEME OF STUDIES

(Semester-Wise Breakdown)

1st Semester

S. No.	Course Code	Course Title	Marks	Credit Hours
1	MCC-201	Islamic Studies	50	2(2-0)
2	MCC-202	English Structure	100	3(3-0)
3	MGC-221	Mechanics	100	3(3-0)
4	MGC-222	Introduction to Economics	100	3(3-0)
5	MFC-231	Calculus-I	100	3(3-0)
6	MMC-251	Discrete Structure	100	3(3-0)
	Total		**550**	**17**

2nd Semester

S. No.	Course Code	Course Title	Marks	Credit Hours
7	MCC-203	Pakistan Studies	50	2(2-0)
8	MCC-204	Introduction to Computer	100	3(2-1)
9	MGC-223	Waves and Oscillations	100	3(3-0)
10	MGC-224	Introduction to Accounting	100	3(3-0)
11	MFC-232	Calculus-II	100	3(3-0)
12	MMC-252	Number Theory	100	3(3-0)
	Total		**550**	**17**

3rd Semester

S. No.	Course Code	Course Title	Marks	Credit Hours
13	MCC-205	Communications Skills	100	3(2-1)
14	MCC-206	Programming Languages C/C++	100	3(2-1)
15	MGC-225	Business Mathematics	100	3(3-0)
16	MGC-226	Introduction to Sociology	100	3(3-0)
17	MGC-227	Electromagnetic Theory	100	3(3-0)
18	MFC-233	Calculus-III	100	3(3-0)
	Total		**600**	**18**

4th Semester

S. No.	Course Code	Course Title	Marks	Credit Hours
19	MCC-207	Computing Tools	100	3(2-1)
20	MGC-228	Introduction to Psychology	100	3(3-0)
21	MGC-229	Modern Physics	100	3(3-0)
22	MFC-234	Algebra-I	100	3(3-0)
23	MMC-253	Probability Theory	100	3(3-0)
24	MMC-254	Basics Topology	100	3(3-0)
	Total		**600**	**18**

5th Semester

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S. No.	Course Code	Course Title	Marks	Credit Hours
25	MFC-235	Algebra-II	100	3(3-0)
26	MFC-236	Real Analysis-I	100	3(3-0)
27	MFC-237	Ordinary Differential Equations	100	3(3-0)
28	MMC-255	Vector and Tensor Analysis	100	3(3-0)
29	MMC-256	Mathematical Statistics	100	3(3-0)
30	MMC-257	Numerical Analysis	100	3(3-0)
	Total		**600**	**18**

6th Semester

S. No.	Course Code	Course Title	Marks	Credit Hours
31	MFC-238	Algebra-III	100	3(3-0)
32	MFC-239	Real Analysis-II	100	3(3-0)
33	MFC-240	Complex Analysis	100	3(3-0)
34	MMC-258	Classical Mechanics	100	3(3-0)
35	MMC-259	Partial Differential Equations	100	3(3-0)
36	MGC-230	Econometrics	100	3(3-0)
	Total		**600**	**18**

7th Semester

S. No.	Course Code	Course Title	Marks	Credit Hours
37	MCC-208	Technical Writing	100	3(3-0)
38	----	Elective-I	100	3(3-0)
39	----	Elective-II	100	3(3-0)
40	----	Elective-III	100	3(3-0)
41	----	Elective-IV	100	3(3-0)
	Total		**500**	**15**

8th Semester

S. No.	Course Code	Course Title	Marks	Credit Hours
42	----	Elective-V	100	3(3-0)
43	----	Elective-VI	100	3(3-0)
44	----	Elective-VII	100	3(3-0)
45	----	Elective-VIII	100	3(3-0)
46	----	Project **OR**Elective-IX	100	3(3-0)
	Total		**500**	**15**

NOTE:
MCC means Mathematics Compulsory Course
MGC means Mathematics General Course
MFC means Mathematics Foundation Course
MMC means Mathematics Major Course
MEC means Mathematics Elective Course

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ELECTIVE COURSES

S. No	Course Code	Course Name	Credit hours
1	MEC-271	General Topology	03
2	MEC-272	Functional Analysis	03
3	MEC-273	Modeling and Simulations	03
4	MEC-274	Advanced Number Theory	03
5	MEC-275	Advanced Partial Differential Equations	03
6	MEC-276	Advanced Numerical Analysis	03
7	MEC-277	Advanced Functional Analysis	03
8	MEC-278	Differential Geometry	03
9	MEC-279	Optimization Theory	03
10	MEC-280	Measure Theory & Integrations	03
11	MEC-281	Fluid Mechanics	03
12	MEC-282	Stochastic Processes	03
13	MEC-283	Integral Equations	03
14	MEC-284	Relativity	03
15	MEC-285	Quantum Mechanics-I	03
16	MEC-286	Quantum Mechanics-II	03
17	MEC-287	Electrodynamics-I	03
18	MEC-288	Electrodynamics-II	03

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COURSE CONTENTS

1st SEMESTER

MCC-201 ISLAMIC STUDIES
Prerequisite: None
Credit Hours: 2+0
Specific Objectives of the Course:
This course is aimed to provide basic information about Islamic studies, to enhance understanding of the students regarding Islamic civilization, to improve student skills to perform prayers and other worships, and to enhance the skill of the students for understanding of issues related to faith and religious life.
Course Outline:
Introduction to Quranic Studies; basics concepts of Quran, history of Quran, Uloom-ul Quran, Study of selected text of Holy Quran; verses of surah Al-Baqra related to faith (verse no:284-286), verses of surah Al-Hujrat related to adab al-nabi (verse no:1-18), verses of surah Al-Muhammad related to characteristics of faithful (verse no:1-11), verses of surah Al-Baqra related to faith (verse no:284-286), verses of surah Al- Furqan related to social ethics(verse no:63-77), verses of surah Al-Inam related to Ihkam(verse no:152-154), verses of surah Al-Ihzab related to adab al-nabi (verse no:6,21,40,56,57,58), verses of surah Al-Hashar related to thinking, day of judgemnet (verse no:18,19,20), verses of surah Al-Saf related to tafakar, tadabar (verse no:1,14),Seerat of Holy Prophet; life of Muhammad in Makkah and Madina, (with focus on the major events), Introduction to Sunnah: basic concepts of Hadith, history of Hadith, Kinds of Hadith, Uloom-ul-Hadith, Sunnah and Hadith, legal position of Sunnah,selected study from text of Hadith, Introduction to Islamic law and Jurisprudence; Isalamic culture and Civilization, Islam and Science, Islamic Economic System, Political system of Islam, Islamic, Social system of Islam.
Recommended Books:

- Ahmad Hasan, *Principles of Islamic Jurisprudence*, Islamic Research Institute, International Islamic University, Islamabad, 1993
- Mir Waliullah, *Muslim Jurisprudence and the Quranic Law of Crimes*, Islamic Book Service, 1982
- H.S. Bhatia, *Studies in Islamic Law, Religion and Society*, Deep and Deep Publications New Delhi, 1989
- M. Zia-Ul-Haq, *Introduction to Al Sharia Al Islami*, Allama Iqbal Open University, Islamabad, 2001
- Muhammad Hammed Ullah, *Introduction to Islam*
- Prof. Khurshid Ahmad, *Islamli Nazriya Hayat*
- Dr. Hamid Ullah, *Khutbathe-e-Bhawapoor*
- Syed Amir Ali, *The Spirit of Islam*

MCC-202 ENGLISH STRUCTURE

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, direct and indirect narrations, practice in unified sentence, analysis of phrase, clause, and sentence structure, transitive and intransitive verbs, the use ofpunctuation marks on and spellings, Comprehension (answering questions on a given text), Discussion (about General and academic topics), Listening (To be improved by showing documentaries/films carefully selected by subject teachers, Translational skills (Urdu to English).

Recommended Books:

- A.J. Thomson and A.V. Martinet, *Practical English Grammar*, 3rd edition, Oxford University Press, 1997
- PC Wren and Martin, *English Grammar and Composition*
- M.C. Boutin, S.Brinand, F.Grellet, *Writing: Intermediate, Oxford Supplementary Skills*
- B.Tomlinson, R.Ellis, *Reading: Upper Intermediate, Oxford Supplementary Skills*

MGC-221 MECHANICS

Prerequisite(s): None

Credit Hours: 3 + 0

Specific Objectives of the Course:

The main objective of this course is to understand different motions of objects on a macroscopic scale and to develop simple mathematical formalisms to analyze such motions. This is a calculus-based introductory course with maximum emphasis on applying the acquired knowledge to solving problems.

Course Outline:

Basic Concepts: Units and Dimensions, SI Units, Changing Units; Scalars and Vectors, Adding Vectors: Graphical as well as Component Method, Multiplying Vectors: Dot and Cross Products.

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

Newton's Laws: Newton's Laws of Motion and their Applications Involving some Particular Forces including Weight; Normal Force; Tension; Friction; and Centripetal Force; Newton's Law of Gravitation; Gravitational Potential Energy; Escape Velocity; Kepler's Laws; Satellite Orbits & Energy.

Work and Kinetic Energy: Work done by Constant and Variable Forces; Gravitational and Spring Forces; Power; Conservative and Non-conservative Forces; Work and Potential Energy; Isolated Systems and Conservation of Mechanical Energy; Work done by External Forces including Friction and Conservation of Energy.

System of Particles: Motion of a System of Particles and Extended Rigid Bodies; Center of Mass and Newton's Laws for a System of Particles; Linear Momentum; Impulse; Momentum & Kinetic Energy in One and Two Dimensional Elastic and Inelastic Collisions.

Rotational Motion: Rotation about a Fixed Axis; Angular Position; Angular Displacement; Angular Velocity and Angular Acceleration; Rotation under Constant Angular Acceleration; relationship between Linear and Angular Variables; Rotational Inertia; Parallel-axis Theorem; Torque and Newton's Law for Rotation; Work and Rotational Kinetic Energy; Power; Rolling Motion; Angular Momentum for a single Particle and a System of Particles; Conservation of Angular Momentum; Precession of a Gyroscope; Static Equilibrium involving Forces and Torques; Rotational inertia of various shapes i.e. for disc, bar and solid sphere; Elasticity; Stress; Strain and Properties of Materials.

Angular Momentum: Angular Velocity; Conservation of angular momentum; effects of Torque and its relation with angular momentum.

Simple Harmonic Motion (SHM): Amplitude; Phase; Angular Frequency; Velocity and Acceleration in SHM; Linear and Angular Simple Harmonic Oscillators; Energy in SHM; Simple Pendulum; Physical Pendulum; SHM and Uniform Circular Motion.

Fluid Mechanics: Static Fluids and Pressure; Archimedes' Principle; Fluid Dynamics; Equation of Continuity and Bernoulli's Principle.

Recommended Book:

- D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", John Wiley & Sons, 9th ed., 2010.
- R. A. Serway and J. W. Jewett, "Physics for Scientists and Engineers", Golden Sunburst Series, 8th ed., 2010.
- R. A. Freedman, H. D. Young, and A. L. Ford (Sears and Zeemansky), "University Physics with Modern Physics", Addison-Wesley-Longman, 13th International ed., 2010.
- F. J Keller, W. E. Gettys and M. J. Skove, "Physics: Classical and Modern, McGraw Hill, 2nd ed., 1992.
- D. C. Giancoli, "Physics for Scientists and Engineers, with Modern Physics", Addison-Wesley, 4th ed., 2008.

MGC-222 INTRODUCTION TO ECONOMICS

Prerequisite(s): None

Credit Hours: 3+ 0

Specific Objectives of the Course:

The main purpose of this course is to familiarize the students with the main concepts used in the field of economics.

Course Outline:

Introduction; Definition, Nature, Scope and Importance (Micro and Macro Economics) Description, Analysis and Policy, Economic Methodology, Consumer Behavior: Definition and meaning, Marginal Utility, Law of Diminishing Marginal Utility Consumer's Surplus Indifference curve approach, Demand: Definition, Laws of Demand, Changes in Demand, Elasticity of Demand and its measurement, Supply: Supply, Changes in supply, Demand and Supply Relationship, Equilibrium Analysis, Production: Concept of Factor of Production, Land Labor, Capital &Entrepreneur, Laws of Returns and their application to Agriculture Sector, Costs: Costs over time period Fixed, Variable, Total, Average and Marginal, Market: Perfect and Imperfect Competition, Price and output determination under perfect and Imperfect competition, Market price and Normal price, Monopoly, Oligopoly, Duopoly and Price Control(Basic Concepts), Factor Pricing: Rent, Wages, Interest and Profit, National Income: Concepts of National Income-GNP, Circular flow of national Income. Measurement of National Income:

National Income at market price, at factor Cost; Measurement of national Product in current rice and in constant prices, Money: Evolution, Forms, Functions, Importance and Role of Money, Value of Money: Quantity Theory of Money, Cash Balance Theory of money, Measurement of Value of Money, Devaluation of Money, Trade Cycle: Phases, Causes & Remedies, Theory of Trade Cycles, Inflation: Kinds, Causes, & Remedies, Balance of Payments: Balance of Trade, Balance of Payments, Causes of Disequilibrium and Measures, Public Finance: Meaning, Difference between Private and Public Finance, Income and Expenditure of Public Bodies, Kinds of Taxes and Cannons of Taxes, Economics in Islam: Economic role of State in Islam, Zakat and Ushr.

Recommended Books:

- Muhammad Irshad, *Economics*, Naveed Publications Lahore
- Sh Manzoor Ali, *Economics*, Ilmi Kutab Khana, Urdu Bazar, Lahore
- Lioyd G Reynolds Irwin, *Micro Economics-Analysis & Policy*, Irwin Homwood Illinois
- Nancy Smith Barrett, *The Theory of Macro Economics Policy*, Prentice Hall
- Edward Shapiro, *Macro Economic Analysis*, Harcourt Brace
- M.A.Saeed Nasir, *Textbook of Economics*, Ilmi Kutab Khana, Lahore
- Salman Rizavi, *Economics*
- P. A. Sameulson, *Economics*

MFC-231 CALCULUS-I

Prerequisite(s): Mathematics at intermediate level

Credit Hours:3+0

Specific Objectives of the Course:

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

Course Outline:

Concept of Function, its different representation and examples, inverse functions, limit and continuity, Derivatives of different functions, applications of differentiation, anti-derivatives and integrals, definite integral, the fundamental theorems of calculus, and its application.

Recommended Books:

- J. Stewart, *Calculus* (5^{th} edition or latest edition), 2002, Brooks/Cole
- H. Anton, I. Bevens, S. Davis,*Calculus: A New Horizen* (8^{th} edition or latest), 2005, John Wiley, New York
- GB.Thomas, AR. Finney, *Calculus* (11^{th} edition or latest edition), 2005, Addison-Wesley, Reading, Ma, USA

MMC-251 DISCRETE STRUCTURE

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:

Mathematical Logic: Introduction, statements, negation, logical connectives, truth table, conjunction, disjunction, conditional and Bi-conditional statements, converse, inverse and contrapositive statements, exclusive or, NAND, NOR, Tautology and contradiction, Predicates and quantifiers, Set theory: sets and its types, operation on sets Binary relation and function: Binary relation, function and its type, Boolean algebra: Introduction, gates and its types, combinatorial circuit of graphs, Boolean expression, Boolean function and its representation. Graph theory: Graph its size, order and types. Matrix representation of a graph, Graph isomorphism, Tree: introduction, fundamental terminology.

Recommended Books:

- S. Epp. Susana, Discrete Mathematics with applications
- D.P. Acharjya, Sreckummar, Discrete Mathematics
- Kenneth H. Rossen, Discrete Mathematics and its applications
- Judith Gersting, Mathematical Structures for Computer Sciences

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2nd SEMESTER

MCC-203 PAKISTAN STUDIES
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:
Pakistan Studies; An Introduction, Ideology of Pakistan; Meaning, Evolution and importance of the Ideology of Pakistan, Reformation Movements and Educational Institutions; Shah Wali Ullah and his Successors, Sir Syed Ahmad Khan and the Aligarh Movement, Dar-ul-Ulam of Deoband, Nadwat-Ul-Ulama, Lucknow, Islamia College Peshawar, Freedom/ Pakistan Movement; Partition of Bengal, Foundation of All India Muslim League (1906), Separate Electorates, Minto-Morley Reforms (1909), Lucknow Pact (1916), Government of India Act (1919), Delhi Proposals (1927), Simon Commission (1927), Nehru Report (1928), Jinnah's Fourteen Points, Allama Muhammad Iqbal and his Allahabad Address (1930), Round Table Conferences (1930-1932), Government of India Act (1935), The General Elections of 1937 and the Congress Ministries, The Lahore Resolution (1940), The Cripps Mission (1942), The General Elections of 1946 and the Transfer of Power, The Cabinet Mission Plan (1946), The Third June Plan and the establishment of Pakistan, Constitutional History of Pakistan; Early Constitution Making Problems, The Objective Resolution (1949), Initials Steps taken for the introduction of Shariah in Pakistan, Geography of Pakistan; Geographical locations of Pakistan; Its importance, Natural Resources of Pakistan, Pakistan and International Community; Foreign Policy of Pakistan, Pakistan and the Muslim World, Kashmir Problem.
Recommended Books:

- Shahid Javed Burki, *State and Society in Pakistan*, The Macmillan Press Ltd, 1980
- Akbar S. Zaidi, *Issue in Pakistan's Economy*, Oxford University Press, 2000
- Mehmood Safdar, *Pakistan Kayyun Toota*, Idara-e-Saqafat-e-Islamia, Club Road, Lahore
- Amin Tahir, *Ethno-National Movement in Pakistan*, Institute of Policy Studies, Islamabad
- Khalid Bin Sayeed, *The Political System of Pakistan*, Houghton Mifflin, Boston, 1967
- Lawrence Ziring, *Enigma of Political Development*, WmDawson and Sons Ltd, England, 1980
- Noor-Ul-Haq, *Making of Pakistan, The Military Perspective*, National Commission on Historical and Cultural Research, 1993
- S.M. Burke and Lawrence Ziring, *Pakistan Foerign Policy: An Historical analysis*, Oxford University Press, 1993

MCC-204 INTRODUCTION TO COMPUTER
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 Outline:

Brief history of computers, major hardware components of a computer, software and its types, operating system, computer security threats and solutions, general applications of computers, network, Internet and its applications, search engines and effective searching, Office automation tools; Word processing, Graphic packages, Databases and Spreadsheets, Current trends, research and future prospects, Number Systems, Binary numbers, Boolean logic, Algorithms, programming, and software development cycle for non-technical users, Social and legal issues.

Recommended Books:

- Brian Williams and Stacey Sawyer, *Using Information Technology*
- Larry Long and Nancy Long, Computers: *Information Technology in Perspective,* 12/e:
- Sherer, Computer Science: *An Overview of Computer Science*
- Asya Sultan Ali, Amina Nudrat, *Fundamentals Concepts of Computer System*, Aays Desktop Publishing

MGC- 223 WAVES AND OSCILLATIONS

Pre-requisites: Mechanics

Credit Hours:3+0

Specific Objectives of the Course:

To develop a unified mathematical theory of oscillations and waves in physical systems

Course Outline:

Simple and Damped Harmonic Oscillation: Mass-Spring System; Simple Harmonic Oscillator Equation; Complex Number Notation; LC Circuit; Simple Pendulum; Quality Factor; LCR Circuit.

Forced Damped Harmonic Oscillation: Steady-State Behavior; Driven LCR Circuit; Transient Oscillator Response; Resonance.

Coupled Oscillations: Two Spring-Coupled Masses; Two Coupled LC Circuits; Three Spring Coupled Masses; Normal Modes; Atomic and Lattice Vibrations.

Transverse Waves: Transverse Standing Waves; Normal Modes; General Time Evolution of a Uniform String; Phase Velocity; Group Velocity.

Longitudinal Waves: Spring Coupled Masses; Sound Waves in an Elastic Solid; Sound Waves in an Ideal Gas.

Travelling Waves: Standing Waves in a Finite Continuous Medium; Traveling Waves in an Infinite Continuous Medium; Energy Conservation; Transmission Lines; Reflection and Transmission at Boundaries.

Wave Pulses: Fourier Series and Fourier Transforms; Wave-Packets and Bandwidth.

Multi-Dimensional Waves: Plane Waves; Three-Dimensional Wave Equation; Electromagnetic waves; Laws of Geometric Optics; Waveguides; Cylindrical Waves.

Interference and Diffraction of Waves: Double-Slit Interference; Single-Slit and Double-slit Diffraction.

Recommended Books:

- J. Pain, "The Physics of Vibrations and Waves", John Wiley, 6th ed., 2005.
- A. P. French, "Vibrations and Waves", CBS Publishers, 2003.

- F. S. Crawford, Jr., "Waves and Oscillations", Berkeley Physics Course, Vol. 3, McGraw-Hill, 1968.
- A. Hirose, and K.E. Lonngren, "Introduction to Wave Phenomena", Krieger Publications, 2003.

MGC-224 INTRODUCTION TO ACCOUNTING

Prerequisite(s): None

Credit Hours:3+0

Specific Objectives of the Course:

The primary aim of this course is to provide students with an introduction to the process and function of financial reporting by the organizations. While a large proportion of the course is aimed at understanding accounting as a process, taking a preparers' perspective. We will also seek to develop an understanding of the importance of the role of accounting in today's society.
After studying this course the student will be able to understand:The language of accounting and financial reporting; Complete Accounting Cycle, Preparation and the role of Journal, Ledger and subsidiary books, and Preparation of balance sheet, profit and loss account and statement of cash flows.

Course Outline:

Accounting and its role, Accounting Defined, Why study Accounting , Financial statements, Major fields of Accounting, Accounting as a Career, Basic Accounting Concepts, The Entity Concept,The Reliability (or Objectivity) principle, The cost Principle,The Going-Concern Assumptions,The Stable Currency Assumptions, Ethics-the-Most Fundamental Principle of Accounting, The recording process,Debit Credit Rules, The Classification Issue, The Recording Process, Analysis of Transaction, The Journal, The Ledger,Balancing the Accounts Preparation of Financial Statements, Preparing Trial Balance, Locating and correcting errors in recording process, Preparing Profit and Loss Account and Balance Sheet The adjusting and closing entries, Need for Adjusting Entries, Recording adjusting entries, Preparing adjusted trial balance, Recording closing entries, Preparing post-closing trial balance, Preparing work-sheet, Preparation of Financial Statements, Accounting for trading organization, Accounting for Purchases and Sales, Return and allowances, Cash and trade Discounts, Periodic System,Perpetual Stock System, Accounting Systems, Subsidiary ledgers, Cash Book, Petty cash book,Control Accounts, Cash and temporary investment,Nature and Composition of Cash, Cash Management and Control,Maintaining Bank Account, Bank Reconciliation, Short term investments,Accounting for debtors and stock,Accounting Treatment of Bad Debts,Direct write-Off Method,Aging Schedule, Percentage of Sales Method, Recoveries of Bad debts Stock, Accounting for property, plant and equipment, Property, Plant and Equipment, Depreciation methods,Revaluation, Review of Useful life, Intangible Assets and Amortization, Wasting Assets and Depletion.

Recommended Books:

- Williams, Haka, Bettner: Financial & Managerial Accounting, Latest Edition, Prentice Hall
- Professor Muhammad Amanullah Khan: Financial Accounting, Latest Edition
- Meigs and Meigs, Accounting for Business Decision, 9th Edition/Latest edition

MFC-232 CALCULUS-II

Prerequisite(s): Calculus-I

Credit Hours:3+0

Specific Objectives of the Course:

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

Course Outline:

Continuation of Calculus I: Techniques of integration, further applications of integration, parametric equations and polar coordinates, sequences and series, power series representation of functions.

Recommended Books:

- J. Stewart, *Calculus* (5th edition or latest edition), 2002, Brooks/Cole
- H. Anton, I. Bevens, S. Davis, *Calculus: A New Horizen* (8th edition or latest), 2005, John Wiley, New York
- GB Thomas, AR Finney, *Calculus* (11th edition or latest), 2005, Addison-Wesley, Reading, Ma, USA

MMC-252 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 (UFT), 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 theorem and its applications, Fibonacci and Lucas Numbers, Fermat Numbers, perfect number and Mersenne primes, Fermat number, Linear Diophantine equation, Reduced residue system, Complete residue system.

Recommended Books:

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

Assistant Registrar (Academics)

3rd SEMESTER

MCC-205 COMMUNICATION SKILLS

Prerequisite(s): English Structure

Credit Hours: 3 + 0

Specific Objectives of the Course:

The course aims at enabling the students to meet their real life communication needs.

Course Outline:

Paragraph writing (practice in writing a good, unified and coherent paragraph), Introduction to Essay Writing, Study Skills (skimming and scanning, intensive and extensive, and speed reading, summary and precise writing, and comprehension), Academic Skills (Letter/memo writing, minutes of meetings, use of library and internet) Presentation Skills (Personality development with emphasis on content, style and pronunciation).

Recommended Books:

- A.J. Thomson and A.V. Martinet, *Practical English Grammar*, 3rd edition, Oxford University Press, 1997
- PC Wren and Martin, *English Grammar and Composition*
- M. C. Boutin, S.Brinand, F.Grellet, *Writing: Intermediate, Oxford Supplementary Skills*
- R. Nolasco, Writing: *Upper Intermediate, Oxford Supplementary Skills*
- B. Tomlinson, R.Ellis, *Reading: Advanced, Oxford Supplementary Skills*
- J. Langan, *Reading and Study Skills*
- R. Yorky, *Study Skills*

MCC-206 PROGRAMMING LANGUAGES C/C++

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

Assistant Registrar (Academics)

MGC-225 BUSINESS MATHEMATICS

Prerequisite(s): Calculus-I, basic arithmetic and algebra skills

Credit Hours:3+0

Specific Objectives of the Course:

Upon completion of this course, students should be able to:

Define the different ways in which interest on money can be calculated

Explain the meaning of simple interest, compound interest, equivalent rates of interest, promissory and demand notes, annuities

Undertake the computations for problems of interest, annuities

Use the results of mathematical calculations to help evaluate various options in reaching financial decisions, whether personal or business-related

Evaluate and select financial arrangements which are best for you as a consumer

Course Outline:

Equations and functions, system of linear equations, mathematical functions, linear functions, quadratic and polynomial functions, exponential and logarithmic functions, finite mathematics (simple interest, compound interest, simple annuities, general annuities, debt reduction, sinking funds), matrix algebra, linear programming, differential calculus and its application in finance, integral calculus and its application in finance.

Recommended Books:

- Frank S. Budnik, *Applied Mathematics for Business, Economics and the Social Sciences*
- Teresa Bradley, Paul Patton, *Essential Mathematics for Economics and Business*
- S.A.Hummel brunner, K. S. Coombs, *Contemporary Business Mathematics with Canadian Applications,* 7th edition, Scarborough, Ontario: Prentice-Hall Canada Inc., 2005
- S.A. Hummel brunner, K. S. Coombs, *Student's Solutions Manual for Contemporary Business*
- *Mathematics with Applications*, 7th edition Scarborough, Ontario: Prentice-Hall Canada Inc., 2005
- Mirza Muhammad Hassan, Muhammad Ali Mirza, *Business Mathematics*

MGC-226 INTRODUCTION TO SOCIOLOGY

Pre-requisite(s): None

Credit Hours: 3+0

Specific Objectives of the Course:

The purpose of the subject is to introduce sociological knowledge and their applications among the students of mathematics. Further, this will help students in understanding of different concepts and their use in practical social life.

Course Outline:

Science, natural science, social sciences, introduction to sociology, relationship with other social sciences e.g. economics, political science, anthropology and history, various perspectives in sociology, introduction to society, elements, characteristics and types of society, introduction to community, essentials and types of community, difference between society and community, introduction to culture, elements, characteristics and types of culture, culture and related concepts, introduction to socialization, agencies of socialization, sociological theories, August Comte, Herbert Spencer, Emile Durkheim, Max Weber, Introduction to social institutions,

family, education, religion, economic, political, introduction to social problems, poverty, unemployment, drug addiction, urbanization, illiteracy, gender disparity.

Recommended Books:

- Paul B. Horton and Hunt, *Introduction to Sociology* 1990, Singapore: McGraw Hill Company
- Anwar Alam, *Principles of Sociology* 2002, Saif Printing Press Peshawar
- Abdul Hameed Tagga, *An Introduction to Sociology* 2009, Alfazal Market Urdu Bazzar, Lahore

MGC-227 ELECTROMAGNETIC THEORY

Prerequisite(s): None

Credit Hours: 3+ 0

Course Outline:

Electric charge &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 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. Milford Fredrick, *Foundations to Electromagnetic Theory*, 2nd edition, Addison-Wesley Publishing Co. 1970

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MFC-233 CALCULUS-III

Prerequisite(s): Calculus II

Credit Hours: 3+0

Specific Objectives of the Course:

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

Vectors and analytic geometry of two and three dimensional space, vector valued functions and space curves, functions of several variables; limit and continuity, partial derivatives, the chain rule, the double and triple integrals with applications, line integrals, the Green's theorem, surface area and surface integrals, the Green's, the divergence and the Stokes theorems with applications.

Recommended Books:

- James Stewart, *Calculus* (5th edition or latest edition), 2002, Brooks/Cole (suggested text)
- H Anton, I Bevens, S Davis, *Calculus: A New Horizen* (8th edition or latest), 2005, John Wiley, New York
- GB Thomas, AR Finney, *Calculus* (11th edition or latest), 2005, Addison-Wesley, Reading, Ma, USA

4th SEMESTER

MCC-207 COMPUTING TOOLS

Prerequisite(s): Introduction to Computer

Credit Hours: 3+0

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 at least one mathematical softwareand 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.

Recommended Books:

- DM. 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

MGC-228 INTRODUCTION TO PSYCHOLOGY

Pre-requisite(s): None

Credit Hours: 3+0

Specific Objectives of the Course:

The subject aims to explore the psychological concepts, techniques, analysis among the students of mathematics. In additions, the course seeks to inculcate the behavior formation and personality development of individuals.

Course Outline:

Introduction to psychology, methods and framework of psychology, development of psychology, modern approaches of social behavior and their implications, the dynamics of human behavior and personality, psychological dynamics, socio-cultural dynamics, man as a psycho bio-social unit, group and social interaction, the nature and types of groups, dimension of group effectives, group change, leadership, and its various forms, characteristics of a good leader, functions of a leader, theories of the leadership, introduction to socialization, agencies of socialization, types of socialization, personality and self, factors of personality development, theories of personality and self, Jean Piaget, Erickson, CH Cooley, Freud, culture and personality, cognition, attitudes, stereotypes, motivation and emotions, perception, public opinion, measurement of public opinion and manipulation of public opinion, mass communication, propaganda, press, film, radio and television, psycho-social problems,suicides, depression, schizophrenia, stress, phobia, psychosis, neurosis.

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Recommended Books:

- Sheriff and Sharif, *An Outline of Social Psychology* 1950. New York, Harper and Row Publishing
- D. Krech, R.S. Crutch Field and Sheri Ballachey, *Individual in Society* 1950, McGraw Hill Book, Company
- Bonner And Hobert, *Social Psychology* 1955, New York, Holt Rinehart And Weston

MGC-229 MODERN PHYSICS

Prerequisite(s): None

Credit Hours: 3+ 0

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 and Walker, *Fundamental of Physics*, Extended ed. John Wiley, 5th edition
- A. Beiser, *Concepts of Modern Physics*, 4th edition McGraw-Hill book Company, 1987

MFC-234 ALGEBRA-I

Prerequisite(s): None

Credit Hours: 3 + 0

Specific Objectives of the Course:

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

Course Outline:

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, rings, fields (definitions and examples), vector spaces, subspaces,

linear dependence and independence, linear span of a subset of a vector space, bases and dimensions of a vector space, algebra of matrices, determinants, matrix of a linear transformation, row and column operations, rank, inverse of matrices, solution of homogeneous and non-homogeneous equations, orthogonal transformation.

Recommended Books:

- H. Anton, *Linear Algebra with Applications*(latest edition), John Wiley, NewYork
- I.N.Herstein, *Topics in Algebra*(latest edition), John Wiley, New York
- RO.Hill, *Elementary Linear Algebra with Application*(3rd edition), 1995, Brooks/Cole
- A. Majeed, *Group Theory*, Ilmi kitab Khana
- Zia-Ul-Haq, *Mathematical Techniques*, Carvan Books Publishers
- S.J.Leon, *Linear Algebra with Applications*(6th edition), 2002, Prentice Hall, Englewood Cliffs, NJ, USA
- WK. Nicholson, *Elementary Linear Algebra with Applications*(2nd edition), 1994, PWS Publishing Company

MMC-253 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:

Statistical measures, statistical description and graphical representation of data, Sets, introduction to probability theory, permutations and combinations, random variables, probability distributions, mean, standard deviation, variance and expectation, Binomial, Poisson, hyper geometric and normal distributions, normal approximation to binomial distribution, distributions of several random variables.

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-254 BASIC TOPOLOGY

Prerequisites: Calculus-I

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:

Basic set theory; 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, 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*
- *General Topology*, Schaum's Outlines Series
- C. Adams, R. Franze, *Introduction to Topology pure and Applied*

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5th SEMESTER

MFC-235 ALGEBRA-II
Prerequisite(s): Algebra-I
Credit Hours: 3 + 0
Specific Objectives of the Course:
This is a course in advanced abstract algebra, which builds on the concepts learnt in Algebra-I.
Course Outline:
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, 1st , 2nd and 3rd sylow theorems,types of rings, matrix rings, rings of endomorphism, polynomial rings, integral domain, characteristic of a ring, ideal, types of ideals, quotient rings, homomorphism of rings, fundamental theorem of homomorphism of rings.
Recommended Books:

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

MFC-236 REAL ANALYSIS-I
Prerequisite(s): Calculus-I and Calculus-II
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: Set and function, completeness properties of real numbers, Absolute value of real number, Supremum and Infimum, open set, closed set, neighborhood, properties of open and closed set, Sequences and series: Convergent sequences and divergent sequences, subsequences, limit of a sequences, properties of a sequences, Cauchy sequences, Properties of Cauchy sequences, Limit and continuity: Limit of a function, Properties of limit, Continuity of a function, properties of continuous function on closed bounded intervals, discontinuity, types of discontinuity, Differentiability and derivability: Derivability and Differentiability, Derivative in one variable, Higher order derivatives, properties of derivable function, Rolle's Theorem, Lagrange's Mean value Theorem, Cauchy Mean Value Theorem, Taylor's Theorem, Generalized mean value theorem, Application to limit Operations, L'Hopital's Rule, Application to maxima and minima, Function of bounded variation: Bounded variation, the decomposition theorem.
Recommended Books:

- R. G. Bartle, DR. 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*

MFC-237 ORDINARY DIFFERENTIAL EQUATIONS

Pre-requisite(s): Calculus-I, Calculus-II

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, determination of particular integral, short methods for finding particular integral, orthogonal trajectories, Cauchy-Euler equations, 2nd order linear differential equations, reduction of order method, undetermined Coefficient method, variations of parameters method, Sturm-Liouville system and boundary value problems, series solution and its limitations, Frobenius methods, solution of the Bessel, the Hypergeometric, the Legendre, and the Hermite equations.

Recommended Books:

- D.G. Zill, M.R, Cullen, *Differential Equations withBoundary-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 (9th edition)
- G.E. Andrews, R. Askey, and R. Roy, *Special Functions*, Cambridge University Press, 2000

MMC-255 VECTOR AND TENSOR ANALYSIS

Prerequisite(s): Calculus-I, Calculus II and Calculus-III

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:

3-D vectors, scalar-and vector-triple products, scalar- and vector-point functions, differentiation and integration of vectors, line integrals, path independence, surface integrals, volume integrals, gradient, divergence and curl with physical significance and applications, vector identities, Green's theorem in a plane, divergence theorem, Stokes' theorem, coordinate systems and their bases, the polar, spherical and the cylindrical-coordinates, tensors of first, second and higher orders, algebra of tensors, contraction of tensors, quotient theorem, quotient theorem, symmetric and skew-symmetric tensors, summation convention, kronecker delta, Levi-Civita symbol,

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vectors as quantities transforming under rotations with notation, alternating symbol, relation between alternating symbol and kronecker delta, invariance property, isotropic tensors, differentiation of tensors, application of tensors in modeling anisotropic systems, study of physical tensors (moment of inertia, index of refraction, etc.), diagnolization of inertia tensor as aligning coordinate frame with natural symmetries of the system.

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-256 MATHEMATICAL STATISTICS

Prerequisite(s): Probability Theory

Credit Hours: 3 + 0

Specific Objectives of the Course:

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

Course Outline:

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

Recommended Books:

- MH. DeGroot, MJ, Schervish, *Probability and Statistics* (3rd edition), 2002, Addison-Wesley, Reading, Ma, USA
- RA. Johnson, *Probability and Statistics for Engineers*, 1994, Prentice-Hall, Englewood Cliffs, NJ, USA
- A.Papoulis, *Probability, Random Variables, and Stochastic Processes*,(3rd edition), 1991, McGraw Hill, New York
- T.Sincich,*Statistics by Examples*, 1990, Dellen Publication Company

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MMC-257 NUMERICAL ANALYSIS

Prerequisite(s): Ordinary Differential Equations

Credit Hours: 3 + 0

Specific Objectives of the Course:

This course is designed to teach the students about numerical methods and their theoretical bases. The students are expected to know computer programming (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.

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, 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.

Recommended Books:

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

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6th SEMESTER

MFC-238 ALGEBRA-III

Prerequisite(s): Algebra-I

Credit Hours: 3 + 0

Specific Objectives of the Course:

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

Course Outline:

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

Recommended Books:

- S.J. Axle, Linear Algebra Done Right, *Undergraduate Texts in Mathematics,* 1996, Springer, New York, Schaum's outlines series
- G.Birkhoff, S. Maclane, *A Survey of Modern Algebra*(4th edition), AKP
- W.L.C. Perry, *Elementary Linear Algebra*, 1988, McGraw-Hill, New York

MFC-239 REAL ANALYSIS-II

Prerequisite(s): Real Analysis-I

Credit Hours: 3 + 0

Specific Objectives of the Course:

A continuation of Real Analysis I, this course rigorously develops integration theory. Like Real Analysis I, Real Analysis II emphasizes on proofs.

Course Outline:

Function of Several Variables: Limit and continuity, Derivability and Differentiability, properties of several variable function, Implicit function, Jacobean, Relative Maxima and Minima, Absolute Maxima and Minima, Riemann Integration: Definition, Riemann integrability, Integrable function, Some fundamental Theorems, Mean value Theorem, Alternative Approaches, Improper Integrals: Definition, test for convergence, Absolute Convergence, The gamma and Beta Functions, Some standard integrals, Multiple Integrals: Double Integration, Double and Triple integral with arbitrary Domain, Riemann-Stieltjes Integrals: The basic notion, Riemann-Stieltjes integral as the limit of a sum, Relation between Riemann and Riemann-Stieltjes Integrals, Properties of Riemann-Stieltjes Integrals.

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*

MFC-240 COMPLEX ANALYSIS

Prerequisites: Real Analysis I

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, JW.Brown, *Complex Variables and Applications* (5th edition), 1989, McGraw Hill, New York
- *Complex Analysis*, Schaum's Outlines Series

MMC-258 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 Outlines:

Introduction: Space and Time, Newton's Laws, The Concepts of Mass and Force, External Forces.

Linear Motion: Conservative Forces; Conservation of Energy, Motion near Equilibrium; the Harmonic Oscillator, Complex Representation, The Law of Conservation of Energy, The Damped Oscillator, Oscillator under Simple Periodic Force, General Periodic Force, Impulsive Forces; the Green's Function Method, Collision Problems.

Energy and Angular Momentum: Energy; Conservative Forces, Projectiles, Moments; Angular Momentum, Central Forces; Conservation of Angular Momentum, Polar Co-ordinates, The Calculus of Variations, Hamilton's Principle; Lagrange's Equations.

Central Conservative Forces: The Isotropic Harmonic Oscillator, The Conservation Laws, The Inverse Square Law, Orbits, Scattering Cross-sections, Mean Free Path, Rutherford Scattering.

Rotating Frames: Angular Velocity; Rate of Change of a Vector, Particle in a Uniform Magnetic Field, Acceleration; Apparent Gravity, Coriolis Force, Larmor Effect, Angular Momentum and the Larmor Effec.

Potential Theory: Gravitational and Electrostatic Potentials, The Dipole and Quadrupole, Spherical Charge Distributions, Expansion of Potential at Large Distances, The Shape of the Earth, The Tides, The Field Equations.

The Two-Body Problem: Centre-of-mass and Relative Co-ordinates, The Centre-of-mass Frame, Elastic Collisions, CM and Lab Cross-sections.

Many-Body Systems: Momentum; Centre-of-mass Motion, Angular Momentum; Central Internal Forces, The Earth–Moon System, Energy; Conservative Forces, Lagrange's Equations

Rigid Bodies: Basic Principles, Rotation about an Axis, Perpendicular Components of Angular Momentum, Principal Axes of Inertia, Calculation of Moments of Inertia, Effect of a Small Force on the Axis, Instantaneous Angular Velocity, Rotation about a Principal Axis, Euler's Angles.

Lagrangian Mechanics: Generalized Co-ordinates; Holonomic Systems, Lagrange's Equations, Precession of a Symmetric Top, Pendulum Constrained to Rotate about an Axis, Charged Particle in an Electromagnetic Field, The Stretched String, Small Oscillations and Normal Modes, Orthogonal Co-ordinates, Equations of Motion for Small Oscillations, Normal Modes, Coupled Oscillators, Oscillations of Particles on a String, Normal Modes of a Stretched String

Hamiltonian Mechanics: Hamilton's Equations, Conservation of Energy, Ignorable Co-ordinates, General Motion of the Symmetric Top, Liouville's Theorem, Symmetries and Conservation Laws, Galilean Transformations.

Recommended Books:

- T. Kibble and F. Berkshire, "Classical Mechanics", World Scientific, 5th ed. 2004.
- T. L. Chow, "Classical Mechanics", John Wiley, 1995.
- S.T. Thornton, J.B. Marion, "Classical Dynamics of Particles and Systems", Brooks Cole; 5th ed. 2003.

MMC-259 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:

Basics concepts of PDEs, origin of PDEs, Derivations of PDEs, solution of linear differential equations of order one using Lagrange's method and its different types, integral surface passing through a given curve, surface orthogonal to a given system of surfaces, linear PDEs with n dependent variables and its solutions, linear homogeneous and non-homogeneous PDEs with constant coefficients and its solutions, PDEs of order two with variable coefficients and its solutions, solution of equations under given geometrical conditions, canonical forms of different kinds of PDEs especially Heat, Wave and Laplace equations, Riemann method of solutions of general linear hyperbolic equations of order two, Monge's method of integration, solution of non-linear PDEs of order one using different techniques, Charpit method for solution of PDEs of order one and of any degree, special methods of solution of PDEs applicable to certain standard forms, the Jacobi method for solution of PDEs with three or more independent variables.

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Recommended Books:

- M. D. Raisinghania, *Ordinary and Partial Differential Equations*, 2006, S Chand Group
- M. D. Raisinghania, *Advanced Differential Equations*, S Chand Group
- D.G. Zill, M.R. Cullen, *Differential Equations withBoundary-Value Problems*,(latest Edition), PWS Publishing Company
- K.Sankara Rao, *Introduction to Partial Differential Equations* (3rd edition) 2002Prentice Hall of India New Delhi
- A.K. Sharma, *Advanced Differential Equations*, Discovery Publishing House, 2010
- C.R.Chester, *Techniques in Partial Differential Equations*, McGraw Hill Book Company, 1971

MGC- 230 ECONOMETRICS

Prerequisite (s): Introduction to Economics, 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*, McGraw Hill, (latest edition)
- Koutsoyiannis, *Theory of Econometrics*, McMillan, (latest edition)
- G.M.K Madnani, *Introduction to Econometrics Principles and Applications*, (latest edition)
- 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

7th SEMESTER

MCC-208 TECHNICAL WRITING

Prerequisite(s): English Structure, Communication Skills

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:

Practice of paragraph writing, Essay writing (descriptive, narrative, discursive, argumentative), Academic writing (How to write a proposal for research paper/term paper with emphasis on style, content, language, form, clarity, consistency), Technical Report Writing, Progress Report Writing,CV and job application.

Recommended Books:

- R.White, *Writing Advanced, Oxford Supplementary Skills*
- J. Langan, *College Writing Skills, McGraw Hill*
- L.G.Kirszner, S.R. Mandell, *Patterns of College Writing, St. Martin's Press*
- J.Neulib, K.S.Cain, S.Ruffus, M.Scharton, The Mercury Reader, Custom Publication, Illinois University

ELECTIVE COURSES (for 7th and 8th Semesters)

MMC-271 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 T_0, T_1, T_2, T_3, T_4 Spaces, Normal and regular and completely regular spaces,Urysohn's lemma and metrization theorem, Countability: Introduction to first and second countable, 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 spaces, 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:

- Dr. 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 Company

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MMC-272 FUNCTIONAL ANALYSIS

Prerequisite(s): Complex Analysis, Basic Topology
Credit Hours: 3 + 0
Course Outline:
Review of metric spaces, Normed spaces: Definition and examples of Normed spaces, convergent sequences, Cauchy sequences, equivalent norm, quotient norm, and theorems on normed space, Banach Spaces: Definition and examples of Banach spaces, Characterization of Banach spaces, Bounded Linear Transformations; Bounded linear operators, 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, The dual (conjugate) spaces, Reflexive spaces, Hahn-Banach Theorem: Hahn-Banach theorem (without proof), 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.
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

MEC-273 MODELING AND SIMULATIONS
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.

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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- 274 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:

- Ivan Niven, Herbert S. Zuckerman and Hugh 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
- Thomas Koshy, *Elementary Number Theory with Applications*, Academic Press is an imprint of Elsevier Kenneth
- H.Rosen, *Elementary Number Theory and its Applications*, Addison-wesley publishing Company

MEC- 275 ADVANCED PARTIAL DIFFERENTIAL EQUATIONS

Pre-requisite(s): Differential Equations

Credit Hours:3+0

Specific Objectives of the Course:

The course provides a foundation to solve partial differential equations with special emphasis on Wave, Heat and Laplace equations. Formulation and some theory of these equations will also be discussed.

Course Outline:

Review of important topics in differential equations, Heat, Wave and Laplace equations and its solution by the method of separation of variable in rectangular, polar, cylindrical and spherical coordinates, Method of Eigen functions and its application, Poisson equation and its solution, Introduction to Laplace Transform and its properties, Important theorems of Laplace transform

method, Laplace transform of some important functions, Inverse Laplace transform and its properties, Convolution theorem, Solution of ODEs and PDEs by Laplace transform method, Introduction to Fourier Transform and its properties, Important theorems of Fourier Transform, Fourier Transform of some important functions, inverse Fourier Transform, Solution of PDEs using Fourier Transform.

Recommended Books:

- Richard Haberman, *Elementary Applied Partial Differential Equations with Fourier Series and Boundary Value Problems* (3rd edition), 1997
- Dennis G. Zill, *Differential Equations with Boundary Value Problem* (6th edition)PWS Publishing Company
- Stanley J. Farlow, *Partial Differential Equations for Scientists and Engineers*, 1993
- K.Sankara Rao, *Introduction to Partial Differential Equations* (3rd edition) 2002Prentice Hall of India New Delhi
- UT Myint, *Partial Differential Equations for Scientists and Engineers* (3rd edition) 1987, North Holand, Amsterdam
- Nakhle H.Asmar, *Partial differential Equation with Fourier Series and Boundary Value Problem* (2nd edition) New Jersey

MEC-276 ADVANCED NUMERICAL ANALYSIS

Prerequisite(s): Numerical Analysis

Credit Hours: 3 + 0

Course Outline:

Differentiation and integration in multidimensional, Ordinary differential equations, Predictor methods, Modified Euler's method, Truncation error and stability, The Taylor series method, Runge-Kutta methods, Differential equations of higher order, System of differential equations; Runge-Kutta methods, shooting methods, finite difference methods, Partial differential equations: Elliptic hyperbolic and parabolic equations; Explicit and implicit finite difference methods, stability, convergence and consistency analysis, 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:

- R.L. Burden, J.D, Faires, *Numerical Analysis*, 9th edition
- C.F.Gerald, *Applied Numerical Analysis*, Addison Wesely, 1984
- C.E. Froberg, *Introduction to Numerical Analysis*, Addison Wesely, 1972
- A.R.Gourlay, and G.A.Watson, *Computational Methods for Matrix Eigen Problems*, John Wiley & Sons 1973
- F. Ahmad, and M.A.Rana, *Elements of Numerical Analysis*, National Book Foundation, Islamabad, 1995

MEC-277 ADVANCED FUNCTIONAL ANALYSIS

Prerequisite(s): Functional Analysis

Credit Hours: 3 + 0

CourseOutline:

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

Recommended Books:

- Kreyszing, E., Introductory Functional Analysis and Applications, John Wiley, 1973
- Taylor, A.E., and Lay, D.C., Introduction of Functional Analysis, John Wiley, 1979
- Heuser, H.G., Functional Analysis, John Wiley, 1982
- Groetsch, C.W., Elements of Applicable Functional Analysis, Marcel Dekker, 1980

MEC- 278 DIFFERENTIAL GEOMETRY

Prerequisites: Differential Equations

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 Co.London
- T.J.Wilmore, *An Introduction to Differential Geometry*, Clarendon Press, Oxford

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MEC-279 OPTIMIZATION THEORY

Prerequisite(s): Algebra-I, Real Analysis-I

Credit Hours: 3 + 0

Specific Objectives of the Course:

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

Course Outline:

Linear programming: simplex method, duality theory, dual and primal-dual simplex methods, Unconstrained optimization: optimality conditions, one-dimensional 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-280 MEASURE THEORY AND INTEGRATIONS

Prerequisite(s): Real analysis-I, II

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

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MEC-281 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, Pathline, Streamline, streamtube, Stream filament, Stream surface, Streakline, 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 mechanicsPHY2009S*, 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-282 STOCHASTIC PROCESSES

Prerequisite(s): Calculus andMathematical 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

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MEC- 283 INTEGRAL EQUATIONS

Prerequisite(s): Differential Equations

Credit Hours: 3 + 0

Course Outline:

Introduction to Integral equation, there 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, Basic fixed point theorem.

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

MEC-284 RELATIVITY
Prerequisite(s): Modern Physics
Credit Hours: 3+0
Course Outline:
Introduction to Einstein's Theory of Special Relativity, Lorentz transformations (one dimensional), length contraction, time dilation and simultaneity, Covariant and contravariant tensors and Einstein Summation convention, velocity addition formulae, 3- dimensional Lorentz transformations, introduction to 4-vector formalism, Lorentz transformations in the 4-vector formalism, the Lorentz and Poincare groups, introduction to classical mechanics, Minkowski spacetime and null cone, 4-velocity, 4-momentum and 4-force, application of special relativity to Doppler shift and Compton effect, particle scattering, binding energy, particle production and decay, electromagnetism in relativity, electric current, Maxwell's equations and electromagnetic waves, the 4-vector formulation of Maxwell's equations, special relativity with small acceleration. Review of analytic geometry in three dimension, Tensors and differential geometry, Isometries and Killing equations, Einstein's theory of relativity, Schwarzschild solution, Gravitational deflection of light, Field theory, Black holes, Relativistic cosmology.
Recommended Books

- H. Golstein, *Classical Mechanics*, Addison Wesley, 1962
- J.B.Kogut, *Introduction to Relativity*
- H.N.Ohanian, *Special relativity: A Modern Introduction*
- R.D.Inverno, *Introducing Einstein's Relativity*, Oxford University Press, 1992
- S. W. Hawking and G. F. R. Ellis, *The Large Scale Structure of Space-time*

MEC-285 ELECTRODYNAMICS-I
Prerequisite(s): Electromagnetic Theory, Calculus-II
Credit Hours: 3 + 0
CourseOutline:
Review of Vector Calculus: vector algebra and calculus, Cartesian coordinates spherical coordinates, differential operators (grad, div, curl).
The Dirac Delta Function: Review of vector calculus using example of Dirac Delta function, The divergence of $\frac{r}{r^2}$, the one-dimensional and the three-dimensional Dirac delta functions. The theory of vector fields: the Helmoholtz theorem, potentials.
Electrostatics: The electric field: introduction, Coulomb's law, the electric field, continuous charge distributions. Divergence and curl of electrostatic fields: field lines, flux and Gauss's law, the divergence of E, applications of Gauss's law, the curl of E. Electric potential: introduction to potential, comments on potential, Poisson's equation and Laplace's equation, the potential of a localized charge distribution, summary, electrostatics boundary conditions, Work and energy in electrostatics: the work done to move a charge, the energy of a point charge distribution, the

energy of a continuous charge distribution, comments on electrostatic energy. Conductors: basic properties, induced charges, surface charge and the force on a conductor, capacitors.
Special Techniques: Laplace's equation: introduction, Laplace's equation in one, two and three dimensions, boundary conditions and uniqueness theorems, conductors and second uniqueness theorems.
The Method of Images: The classic image problem, induced surface charge, force and energy, other image problems.
Multipole Expansion: Approximate potential at large, the monopole and dipole terms, origin of coordinates in multipole, expansions, the electric field of a dipole.
Electric Fields in Matter-Polarization: dielectrics, induced dipoles, alignment of polar molecules, polarization. The field of a polarized object: bound charges, physical interpretation of bound charges, and the field inside a dielectric. The electric displacement: Gauss's law in the presence of dielectrics, a deceptive parallel, boundary conditions. Linear Dielectrics: susceptibility, permittivity, dielectric constant, boundary value problems with linear dielectrics, energy in dielectric systems, forces on dielectrics.
Magnetostatics: The Lorentz Force law: magnetic fields, magnetic forces, currents. The Biot-Savart Law: steady currents, the magnetic field of a steady current. The divergence and curl of B: straight-line currents, the divergence and curl of B, applications of Ampere's law, comparison of magnetostatics and electrostatics. Magnetic Vector Potential: the vector potential, summary, magnetic boundary conditions, multipole expansion of the vector potential.
Magnetic Fields in Matter: Magnetization, diamagnets, paramagnets, ferromagnets, torques and forces on magnetic dipoles, effect of a magnetic field on atomic orbits, magnetization. The Field of a Magnetized Object: bound currents, physical interpretation of bound currents, and the magnetic field inside matter. The auxiliary field H: Ampere's law in magnetized materials, a deceptive parallel, boundary conditions. Linear and nonlinear media: magnetic susceptibility and permeability, ferromagnetism.

Recommended Books:

- D.J. Griffiths, "Introduction to Electrodynamics", Prentice Hall, 3rd ed. 1999.
- M. N. O. Sadiku, "Elements of Electromagnetics", . Oxford University Press, 5th ed.2009.
- F. Mèlia, "Electrodynamics", University of Chicago Press, 2001.
- Hearld J and W. Muller-Kristen, "Electrodynamics", World Scientific Pub, 2nd ed. 2011.

MEC-286 ELECTRODYNAMICS-II

Prerequisite(s): Electrodynamics-I

Credit Hours: 3 + 0

Specific Objectives of the Course:

This course is the second part of the core level undergraduate course on Electromagnetic Theory and a previous knowledge of Electromagnetic Theory I is expected.

CourseOutline:

Electrodynamics: Electromotive force: Ohm's law, electromotive force, motional emf, electromagnetic induction: Faraday's law, the induced electric field, inductance, energy in magnetic fields, Maxwell's equations: electrodynamics before Maxwell, how Maxwell fixed Ampere's law, Maxwell's equations, magnetic charges, Maxwell's equations in matter, boundary conditions.

Conservation Laws: Charge and energy: the continuity equation, Poynting's theorem, momentum: Newton's third law in electrodynamics, Maxwell's stress tensor, conservation of momentum, angular momentum.
Electromagnetic Waves: Waves in one dimension: the wave equation, sinusoidal waves, boundary conditions, reflection and transmission, polarization, electromagnetic waves in vacuum: the wave equation for E and B, monochromatic plane waves, energy and momentum in electromagnetic waves, electromagnetic waves in matter: propagation in linear media, reflection and transmission at normal incidence, reflection and transmission at oblique incidence, absorption and dispersion: electromagnetic waves in conductors, reflection at a conducting surface, the frequency dependence of permittivity, guided waves: wave guides, the waves in a rectangular wave guide, the coaxial transmission line.
Potentials and Fields: The potential formulation: scalar and vector potentials, gauge transformations, Coulomb gauge and Lorentz gauge, continuous distributions: retarded potentials, Jefimenko's equations, point charges: Lienard-Wiechert potentials, the field of a moving point charge.
Radiation, Dipole Radiation: What is radiation, electric dipole radiation, magnetic dipole radiation, radiation from an arbitrary source, point charges: power radiated by a point charge, radiation reaction, the physical basis of the radiation reaction.
Electrodynamics and Relativity: The special theory of relativity: Einstein's postulates, the geometry of relativity, the Lorentz transformations, the structure of space-time, relativistic mechanics: proper time and proper velocity, relativistic energy and momentum, relativistic kinematics, relativistic dynamics, relativistic electrodynamics: magnetism as a relativistic phenomenon, how the field transform, the field tensor, electrodynamics in tensor notation, relativistic potentials.

Recommended Books:

- D. J. Griffiths, "Introduction to Electrodynamics", ed. Prentice Hall, 3rd ed. 1999.
- M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Press, 5th Ed, 2009.
- F. Melia, "Electrodynamics", University of Chicago Press, 1st ed. 2001.
- Heard J and W. Muller-Kristen, "Electrodynamics", World Scientific Publishing, 2011.

MEC-287 QUANTUM MECHANICS-I

Prerequisite(s): Modern Physics

Credit Hours: 3 + 0

Course Outline:

Waves and Particles: Introduction to the fundamental ideas of quantum mechanics: Electromagnetic waves and photon, material particles and matter waves, quantum description of a particle, wave packets, particle in a time-independent scalar potential, order of magnitude of the wavelength associated with material particles, constraints imposed by uncertainty relations, one-dimensional Gaussian wave packet: Spreading of the wave packet, stationary states of a particle in one-dimensional square potential, behavior of a wave packet at a potential step.
The Mathematical Tools of Quantum Mechanics: One-particle wave function space, state space, Dirac notation, representations in the state space, observable, representations, review of some useful properties of linear operators, unitary operators, study of the $\{|r\rangle\}$ and $\{|p\rangle\}$ representations, some general properties of two observable, Q and P, whose commutator is equal to $i\hbar$, the two-dimensional infinite well.

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The Postulates of Quantum Mechanics: Statement of the postulates and their physical interpretation, the physical implications of the Schrodinger equation, the superposition principle, particle in an infinite potential well, study of the probability current in some special case, root-mean-square deviations of two conjugate observables, the density and evolution operators, Schrodinger and Heisenberg pictures, Gguge invariance, bound states of a particle in a potential well of arbitrary shape, unbound states of a particle in the presence of a potential well or barrier of arbitrary shape, quantum properties of a particle in a one-dimensional periodic structure.

Application of The Postulates to Simple Cases: Spin ½ And Two-Level Quantum Systems: Spin ½ particles, quantization of the angular momentum, illustration of the postulates in the case of a spin ½, general study of two level systems, Pauli matrices, diagonalization of a 2×2 hermitian matrix, System of two spin ½ particles, Spin ½ density matrix, Spin ½ particle in a static magnetic field and a rotating field, Magnetic resonance.

The One-Dimensional Harmonic Oscillator: Importance of the harmonic oscillator in physics, eigenvalues and eigenstates of the Hamiltonian, mean value and root-mean-square deviations of X and P in state $|\varphi_n\rangle$, Some examples of harmonic oscillators, study of the stationary states in the $\{|r\rangle\}$ representation, Hermite polynomials, solving the Eigenvalues of the harmonic oscillators by the polynomial method, study of the stationary states in the $\{|p\rangle\}$ representation, isotropic three-dimensional harmonic oscillator, charged harmonic oscillator placed in a uniform electric field, coherent states, Normal vibrational modes of coupled harmonic oscillators, vibrational modes of an infinite linear chain of coupled harmonic oscillators, phonons, one-dimensional harmonic oscillator in thermodynamics equilibrium at a temperature T.

General Properties of Angular Momentum in Quantum Mechanics: concept of angular momentum in quantum mechanics, commutation relations, application to orbital angular momentum, spherical harmonics, rotation operators, rotation of diatomic molecules, angular momentum of stationary states of a two-dimensional harmonic oscillator, charged particle in a magnetic field and Landau levels.

Particle in a Central Potential: The Hydrogen atom, Stationary states of a particle in a central potential, motion of the center of mass and relative motion for a system of two interacting particles, Hydrogen atom, Hydrogen-like systems, A solvable example of a central potential: the isotropic three-dimensional harmonic oscillator, probability currents associated with the stationary states of the hydrogen atom, The hydrogen atom placed in a uniform magnetic field, paramagnetism and diamagnetism, Zeeman effect, study of some atomic orbitals, vibrational-rotational levels of diatomic molecules.

Recommended Books:

- D.J. Griffiths, "Introduction to Quantum Mechanics", Addison-Wesley, 2nd ed. 2004.
- R. Liboff, "Introductory Quantum Mechanics", Addison-Wesley, 4 ed. 2002.
- N. Zettili, "Quantum Mechanics: Concepts and Applications", John Wiley, 2nd ed. 2009.

MEC-288 QUANTUM MECHANICS-II

Prerequisite(s): Quantum Mechanics-I

Credit Hours: 3 + 0

Course Outline:

Addition of Angular Momenta: Total angular momentum in classical mechanics, total angular momentum in quantum mechanics, addition of two spin ½ angular momenta, addition of two arbitrary angular momenta, Clebsch-Gordon coefficients, sddition of spherical harmonics, vector

operators, Wigner-Eckart theorem, electric Multipole moments, Evolution of two angular momenta J_1 and J_2 coupled by an interaction a $J_1 . J_2$.

Stationary Perturbation Theory: Description of the method, perturbation of a non-degenerate level, perturbation of a degenerate level, one-dimensional harmonic oscillator subjected to a perturbing potential, interaction between the magnetic dipoles of two spin ½ particles, Van der waals forces, volume effect and The influence of the spatial extension of the nucleus on the atomic levels, variational method, energy bands of electrons in solids, a simple example of the chemical bond: The H_2^+ ion.

Applications of Perturbation Theory to Atomic Systems: fine and hyperfine structure of atomic levels in hydrogen, Calculation of the mean values of the spin-orbit coupling in the 1s, 2s and 2p levels, hyperfine structure And the Zeeman effect for muonium and positronium, Stark effect.

Approximation Methods for Time-Dependent Problems: Statement of the problem, approximate solution of the Schrodinger equation, An important special case: Sinusoidal or constant perturbation, Interaction of an atom with electromagnetic waves, linear and non-linear response of a two-level system subjected to a sinusoidal perturbation, Ooscillations of a system between two discrete states under the effect of a resonant perturbation, Rabi flopping, decay of discrete state resonantly coupled to a continuum of final states, Fermi's golden rule.

Systems of Identical Particles: Identical particles, Permutation operators, The symmetrization postulate, difference between bosons and fermions, Pauli's exclusion principle, many-electrons atom and their electronic configurations, energy levels of the helium atom, configurations, terms, multiplets, spin isomers of hydrogen (ortho and parahydrogen).

Scattering. by a Potential: Importance of collision phenomena, Stationary scattering states, scattering cross section, scattering by a central potential, method of partial waves, phenomenological description of collisions with absorption.

Recommended Books:

- D.J. Griffiths, "Introduction to Quantum Mechanics", Addison-Wesley, 2nd ed. 2004.
- R. Liboff, "Introductory Quantum Mechanics", Addison-Wesley, 4th ed. 2002.
- N. Zettili, "Quantum Mechanics: Concepts and Applications", John Wiley, 2nd ed. 2009.

Assistant Registrar (Academics)
University of Malakand