

BS (4 YEARS) DEGREE IN MATHEMATICS

In accordance with HEC's 2020 Undergraduate Policy



Session 2020 and onwards

HOD, Department of Mathematical Science, ULM

Director Academics, ULM

BS-Scheme of Studies in Mathematics

[Semester-wise break up](#)

BS Mathematics (4-years Program) Semester-Wise Breakdown

First Year

Semester-I

S. N	Course Code	Course Title	Cr. Hrs
1	ENG-101	English – I	3(3 + 0)
2	AH-105	Islamic History	3(3 + 0)
3	NS-101	Everyday Science	3(3 + 0)
4	QR-102	Information & Communication Technology	3(3 + 0)
5	SS-120	Sociology	3(3 + 0)
6	QR-104	Introduction to statistics	3(3 + 0)
Total			18(18 + 0)

Semester-II

S. N	Course Code	Course Title	Cr. Hrs
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1	QR-101	Basic Mathematics	3(3 + 0)
2	SS-113	Introduction Economics	3(3 + 0)
3	NS-120	Introduction Physics	3(3 + 0)
4	CIV-110	Islamic history	3(3 + 0)
5	AH-120	Constitutional Law	3(3 + 0)
6	ENG-121	English-II (Communication Skills)	3(3 + 0)
Total			18(18 + 0)

Second Year

Semester-III

S. N	Course Code	Course Title	Cr. Hrs
1	MATH-211	Calculus-I	3(3 + 0)
2	MATH-212	Set Theory and Mathematical Logics	3(3 + 0)
3	MATH-213	Number Theory	3(3 + 0)
4	ENG-231	English-III (Technical Writing and Presentation Skills)	3(3 + 0)
5	PHY-101	Mechanics-I	3(3 + 0)
6	PS-231	Pakistan Study	3(3 + 0)
Total			18(18+ 0)

Semester-IV

S. N	Course Code	Course Title	Cr. Hrs
1	MATH-221	Calculus-II	3(3 + 0)
2	MATH-218	Algebra-1	3(3 + 0)
3	MATH-223	Basic Topology	3(3 + 0)
4	MATH-219	Ordinary Differential Equations	3(3 + 0)
5	PHY-211	Mechanics-II	3(3 + 0)
Total			15(15 + 0)

Third Year

Semester-V

S. N	Course Code	Course Title	Cr. Hrs
1	MATH-316	Real Analysis-I	3(3 + 0)
2	MATH-311		3(3 + 0)
3		Affine and Euclidean Geometry	3(3 + 0)
4	MATH-314	General Topology	3(3 + 0)
5	MATH-317	Differential Geometry	3(3 + 0)
6	MATH-315	Computational Tools For Mathematics	
Total			15(15 + 0)

Semester-VI

S. N	Course Code	Course Title	Cr. Hrs
1	MATH-321	Real Analysis-II	3(3 + 0)
2	MATH-322	Complex Analysis	3(3 + 0)

3	MATH-323	Mathematical Methods	3(3 + 0)
4	MATH-324	Group Theory	3(3 + 0)
5	MATH-325	Rings and Fields	3(3 + 0)
Total			15(15 + 0)

Forth Year

Semester-VII

S. N	Course Code	Course Title	Cr. Hrs
1	MATH-411	Functional Analysis-I	3(3 + 0)
2	MATH-412	Numerical Analysis-I	3(3 + 0)
3	MATH-413	Integral Equations	3(3 + 0)
4	MATH-XXX	Elective-I	3(3 + 0)
5	MATH-XXX	Elective-II	3(3 + 0)
Total			15(15 + 0)

Semester-VIII

S. N	Course Code	Course Title	Cr. Hrs
1	MATH-421	Numerical Analysis-II	3(3 + 0)
2	MATH-422	Functional Analysis-II	3(3 + 0)
3	MATH-XXX	Elective-III	3(3 + 0)
4	MATH-XXX	Elective-IV	3(3 + 0)
5	MATH-500	Project	6(6 + 0)
Total			18(18 + 0)

Note: *Student coming from other disciplines in associate degree program should take the following courses as bridging semester for enrolment into BS in Mathematics.*

Bridging Semester				
Code	Title	Credit hours		
PHY-101	Introductory Mechanics	3	0	3
MATH-211	Calculus-1	3	0	3
MATH-315	Computational Tools For Mathematics	3	0	3

MATH-452	Basic Topology	3	0	3
MATH-212	Set Theory and Mathematical Logics	3	0	3
MATH-223	Number Theory	3	0	3
MATH-219	Ordinary Differential Equations	3	0	3

Major Courses including Research Project
11 - 13 courses
33 - 42 Cr. Hours

4 courses
12 Cr. Hours

Subject	C.Hs	Subject	C.Hs
1. Number Theory	03	1. Elective-I	03
2. Basic Topology	03	2. Elective-II	03
3. Real Analysis-I	03	3. Elective-III	03
4. General Topology	03	4. Elective-IV	03
5. Differential Geometry	03		
6. Real Analysis-II	03		
7. Mathematical Methods	03		
8. Rings and Field	03		
9. Functional Analysis-I	03		
10. Numerical Analysis-I	03		
11. Probability Theory	03		
12. Functional Analysis-II	03		
13. Project	06		

Elective Courses

Semester VII			
S. N	Course Code	Course Title	Credit Hours
1	MATH-414	Vector and Tensor	3(3+0)
2	MATH-415	Fluid Mechanics-I	3(3+0)
3	MATH-416	Mathematical Statistic	3(3+0)
4	MATH-417	Measure and Integration	3(3+0)
5	MATH-418	Dynamics	3(3+0)
6	MATH-419	Optimization Theory-I	3(3+0)
Semester VIII			
S. N	Course Code	Course Title	Credit Hours
1	MATH-423	Partial Differential Equation	3(3+0)
2	MATH-424	Probability Theory	3(3+0)
3	MATH-425	Introduction to Fixed Point Theory	3(3+0)
4	MATH-426	Fluid Mechanics-II	3(3+0)
5	MATH-427	Fuzzy Set Theory and Applications	3(3+0)
6	MATH-428	Mathematical Modeling	3(3+0)
7	MATH-429	Optimization Theory-II	3(3+0)

ENG-101:English I: Reading & Writing Skills

Chrs:3

Course Description:

The course is designed to help students take a deep approach in reading and writing academic texts which involve effective learning strategies and techniques aimed at improving the desired skills. The course consists of two major parts: the 'reading section' focuses on recognizing a topic sentence, skimming, scanning, use of cohesive devices, identifying facts and opinions, guess meanings of unfamiliar words. The 'writing section' deals with the knowledge and use of various grammatical components such as, parts of speech, tenses, voice, narration, modals etc. in practical contexts.

Course Contents

1. Reading Skills

- Identifying Main Idea / Topic sentences
- Types of Reading Skills: skimming, scanning, extensive and intensive
- Active and Passive Reading
- Strategies for Improving Reading Skills
- Finding Specific and General Information Quickly
- Distinguishing Between Relevant and Irrelevant Information According to Purpose for Reading

- Recognizing and Interpreting Cohesive Devices
- Distinguishing Between Fact and Opinion
- Reading Comprehension

2. Writing Skills

- Sentence patterns and structures
- Phrase, clause
- Parts of Speech
- Tenses: meaning and use
- Modals
- Use of active and passive voice
- Reported Speech
- Writing good sentences
- Error Free writing
- Paragraph writing with topic sentence

Recommended Readings

- Howe, D. H, Kirkpatrick, T. A., & Kirkpatrick, D. L. (2004). *Oxford English for undergraduates*. Karachi: Oxford University Press.
- Eastwood, J. (2004). *English Practice Grammar* (New edition with tests and answers). Karachi: Oxford University Press.
- Murphy, R. (2003). *Grammar in use*. Cambridge: Cambridge University Press.

AH-105: Islamic History (Compulsory)

CHrs: 03

Objectives:

This course is aimed at:

- To provide basic information about Islamic History
- To provide basic information to the students about the life of the Holy Prophet Hazrat Muhammad (S.A.W).
- To inform the students about the administrative system of Califate Rashida period.
- To inform the students about the rule and administrative system of Umayyad period, Abbasids period and Muslims in Spain.
- To enhance understanding of the students regarding Islamic Culture and Civilization.
- To enhance skills of the students for understanding of issues related to faith and religious life.
- To communicate historical knowledge effectively and pursue higher studies in History and related fields.

Course Contents:

Part. 1 Life of the Holy Prophet Hazrat Muhammad (S.A.W)

1. Land and Geography of Arabia
2. Conditions of Arabia at the advent of Islam
3. Makki Life of the Holy Prophet (S.A.W)
 - 3.1 Parentage, Birth and Early Childhood
 - 3.2 Harb ul Fajjar, Half fu Fazool, Nikah and Re-Construction of Kaba
 - 3.3 Baasat e Nabvi, Preeching of Islam and Hostility of Quraish
 - 3.4 Emigration to Abyssinia 1st and 2nd , Aam ul Huzn, Pledge of Aqba 1st and 2nd
 - 3.5 Hijrat e Madina

4. Madni Life of the Holy Prophet (S.A.W)
 - 4.1 Causes, Events and Importance of Hijrat e Madina
 - 4.2 Charter of Madina
 - 4.3 Gazwat e Nabvi, Treaty of Hudaibiya and Conquest of Makkah
5. Last Sermon of the Holy Prophet (S.A.W)
6. Seerat tu Nabi (S.A.W)

Part. 2 Rashidun' Period

1. Hazrat Abu Bakr Saddiq (R. A)
2. Hazrat Umar Farooq (R. A)
3. Hazrat Usman (R. A)
4. Hazrat Ali (R. A)
5. Administration system and main Features of Rashidun Period

Part. 3 Umayyads' Period

1. Hazrat Amir Mu'awiya (R. A)
2. Yazed and Karbala incident
3. Hazrat Abdullah bin Zubair (R. A)
4. Marwan and Abdul Malik bin Marwan
5. Walid bin Abdul Malik and Sulaiman bin Abdul Malik
6. Hazrat Umar bin Abdul Aziz (R. A)
7. Later Rulers of Umayyad Dynasty
8. Administration under Umayyads and causes of their downfall

Part. 4 Abbasids' Period

1. As-Safah and Abu Jafr Al-Mansoor
2. Hadi, Mahdi, Haroon ur Rashid
3. Amin, Mamoon and Moatasim
4. Later Rulers of Abbasids' Dynasty
5. Administration under Abbasids and causes of their downfall
6. Crusades and Sultan Salah ud Din Ayubi
7. Muslims in Spain
8. Administration and Causes of the downfall of Muslims in Spain

Recommended Books:

- Islamic History (P-I and P-II). Published by KP Textbook Board Peshawar.
- Dr. Hameed du Din. "Tareekh e Islam".
- Mazar ul Haq. "History of the Arabs".
- Shah Moeen ud Din. "Tareek e Islam".
- تاريخ الخلفاء (اردو ترجمہ).....علامہ جلال الدين سيوطي
- خلافت اندلسنواب ذوالقدر جنگ
- تاريخ اندلسمولانا رياست علي ندوي
- تاريخ اسلاماكبر شاه خان نجيب آبادي
- تاريخ الامم والملوك (اردو ترجمہ).....ابن جرير طبري

SS-120: Principles of Sociology

CHrs: 03

Course Contents

- 1. Fundamental of Sociology**
 - 1.1 Nature, Scope, and subject matter of Sociology
 - 1.2 Brief historical development of Sociology
 - 1.3 Society and community

- 1.4 Relationship with other social sciences like Economic, Political Science, History, Psychology, and Anthropology.
- 1.5 Social interaction processes (Cooperation, Competition, Conflict, Accommodation, Acculturation, and Assimilation).
- 2. Social Groups**
 - 2.1 Definition and Functions
 - 2.2 Types of Social Groups (In and out group, Primary and Secondary groups, Reference groups. Formal and informal Groups and Pressure groups)
- 3. Social Institutions**
 - 3.1 Definition, Structure and Function of the following Institutions: Family, Religion, Education, Economics, Political Inter-relationship among various social institutions.
- 4. Cultural and Related Concepts**
 - 4.1 Definition and aspects of culture, Material and non-material culture, Ideal and real culture
 - 4.2 Elements of culture, Beliefs, values, norms (folkways, mores, laws)
 - 4.3 Organization of culture, Traits, complexes, and patterns
 - 4.4 other related concepts, Cultural relativism, Sub-Culture and ethnocentrism
- 5. Socialization and Personality**
 - 5.1 Role and Status
 - 5.2 Socialization
 - 5.3 Culture and Personality
- 6. Deviance and Social Control**
 - 6.1 Definition and types of deviance
 - 6.2 Formal and informal methods of social control

Social Stratification

- 1.1 Determinants of Social Stratification (Caste, Class, Ethnicity, Power, Prestige and Authority)
- 1.2 Social Mobility, Definition and types
- 1.3 Dynamics of social mobility
- 2. Social and Cultural Change**
 - 2.1 Definition of social change
 - 2.2 Dynamics of social change (Education, Innovation, Industrialization, Urbanization and Diffusion)
 - 2.3 Resistance to change

Suggested Readings:

- i. *Horton Paul B. and Hunt, Chester L (1990), Sociology Singapore: McGraw Hill Book Company.*
- ii. *Sociology 1 by Allama Iqbal Open University, Islamabad*
- iii. *Sociology 2 by Allama Iqbal Open University, Islamabad*
- iv. *Taga, Abdul Hameed (2000) An Introduction. New York: Harper and Rows*
- v. *Betnad, Alvin L. (1969). Basic Sociology-An Introduction to Theory and Methods, New York; Appleton Century Crofts.*
- vi. *Curran, Jr.(1977).Introductory sociology: A basis Self Instructional Guide*
- vii. *Hafeez, Sabeeha (1990), The Changing Pakistan Society. Karachi: Royal Book company, Zaibunisa Street, Sadar.*

- viii. *Horton Paul B. and Hunt, Chester I.. (1990) Sociology singapore.Macgraw Hill Book Company.*
- ix. *Merrii, F.E., (latest ed.), Sociology and Culture. N.J. Englewood Cliffs.*
- x. *Philips, Bernard (1990). Sociology-Form Concepts to Practice. New York: McGraw Hill Book Company Inc.*
- xi. *Rao, C. Nshaukar (1990), Sociology, New Delhi: S.C Chand and Company Ltd.*

QR-104: Introduction to Statistics**CHrs:3****Course Objectives**

- The course will impart knowledge and understanding of Statistics. To provide knowledge about the importance and use of statistics in life sciences.
- To familiar students with the methods of data analysis pertaining to their research work and to assess the significance of their experimental designs.

Course Outcomes:

Students who successfully complete this course will be able to:

- **DESCRIBE** the roles Statistics serves in their subject and research.
- **APPLY** numerical, tabular, and graphical descriptive techniques commonly used to characterize and summarize data.
- **EXPLAIN** general principles of study design and its implications for valid inference.
- **ASSESS** data sources and data quality for selecting appropriate data for specific research questions.
- **TRANSLATE** research objectives into clear, testable statistical hypotheses.
- **DESCRIBE** basic principles and the practical importance of key concepts.

Recommended Books

1. “Statistical Theory Part-I and Part-II By Sher Mohammad Chaudary, Carwan Publisher.
2. Statistics 4th Edition, “Schaum’s Outline Series, McGRAW-HILL
3. Basic Concepts and Methodology for the Health Sciences By Wayne W. Daniel
4. Wayne W. D., (2005). Biostatistics: A foundation for Analysis in the health sciences. Wiley series in Probability and Statistics
5. Earl K. Bowem & Martin Starr: Basic Statistics for Business and Economics.

WEEK WISE BREAKDOWN

Week	Description
1	A) Basic of Statistics: <ul style="list-style-type: none"> • Introduction to Statistics • Scope and importance of statistics • Meaning of Statistics according to the subject. • Branches of Statistics
2	<ul style="list-style-type: none"> • Population and sample, Parameter and Statistic • Variable and Constant • Discrete and continuous variable • Data and its types (Qualitative and Quantitative)
3	<ul style="list-style-type: none"> • Scales of measurements (Nominal, Ordinal, Interval and Ratio) • Diagrams and graphs • Simple and Multiple bar chart • Histogram, Pie chart

4	B) Frequency distribution (FD) <ul style="list-style-type: none"> • Definition of frequency distribution • Steps in construction of frequency distribution
5	C) Measures of Central Tendency <ul style="list-style-type: none"> • Arithmetic mean • Real life examples for group and ungroup data
6	<ul style="list-style-type: none"> • The Median • Uses of Median • Applications of Median for simple and frequency data
7	<ul style="list-style-type: none"> • The Mode • Uses of Mode • Applications of Mode for simple and frequency data
8	D) Measures of Dispersion <ul style="list-style-type: none"> • Definition and types of dispersion • Range, grouped and ungrouped data Coefficient of range • Standard deviation, variance and Co-efficient of variance
Two Assignments + Test Mid Term Exam	
9	E) Probability <ul style="list-style-type: none"> • Definition of probability • Objective and Subjective probability. • Experiment and random experiment, sample space and sample point,
10	<ul style="list-style-type: none"> • Event, simple and composite events. • Mutually exclusive and independent events • Calculation of probability relative to dice, coins and balls.
11	F) Sampling <ul style="list-style-type: none"> • Sampling and sampling distribution • Probability and non-probability sampling
12	G) Estimation <ul style="list-style-type: none"> • Definition of Estimation • Estimator and Estimate • Definition of Point and Interval Estimation
13	H) Hypothesis Testing <ul style="list-style-type: none"> • Hypothesis, Statistical Hypothesis and Testing of Hypothesis • Simple and Composite hypothesis • Steps of hypothesis testing

14	<ul style="list-style-type: none"> • Definition of Student t-test • Properties of t-test • Real life examples of t-test for single population mean
15	D)Regression and Correlation <ul style="list-style-type: none"> • Definition of Regression • Estimated regression line • Solution of Real life Problems for simple regression
16	Correlation <ul style="list-style-type: none"> • Definition of Correlation • Pearson correlation coefficient • Solution of Real life Problems
Two Assignments + Two Test+ Presentation	
Final Term	

NS- 101: EVERYDAY SCIENCE

CHrs: 03

Course outline:

Introduction, History of Science, Achievements of some giants of Science in Chronological order, Islamic Science, Contribution of Muslim Scientists, Famous muslim scientist, Nature of science, Scientific method, impact of science on society. Introduction, The origin, The Big Bang, The structure, the galaxies, solar system, The sun, the moon, the earth, structure of the earth, earth atmospheres, the greenhouse effect, global warming, ozone depletion, acid rain, satellites, earthquake, eclipses, the mystery of Stonehenge, day-night and seasons, volcanoes, minerals, glossary of cosmology Introduction and sources of energy, Fossil Fuels, Major oil producing countries, Global search of Crude oil, Petroleum products, natural gas, hydro power or hydro-electric power, solar energy, nuclear energy, the nuclear reactor, heavy water, nuclear safety, nuclear fusion, energy conversion, radiation and living things, Ceramics, Semi-conductors, Communications systems, Laser, Telescope, Camera, Fertilizers, Nanotechnology, Plastics, Computer, Brain, Heart, Tissues, Epithelial Cell, Origin of Modern Humans, Pest Control, Protein, Vertebrate, Invertebrate, Liver, Enzymes, Organisms (Common to all living things), Blood Group system. Plants, Seed, Flower, Gene, Evolution Laws, Nucleic Acid (DNA and RNA), **Diseases and Threats to Living organism:**

Swine flow, Hepatitis, Dengue fever, Corona virus, SARS (Severe acute respiratory syndrome virus), Plants and Crop Diseases (Rust, Smut, Late Blight, Canker).

Recommended Books:

1. Exploring physical science 1977 by walter A. Thurber
2. Exploring Life science 1975 by walter A. Thurber
3. Encyclopedic Manual of everyday science, Author, Dr. Rabnawaz Samo Publisher; Maktab e Faridi.

ICT-107: Information and Communication Technologies CHrs:3

COURSE OBJECTIVES:

Students successfully completing this course should be able to:

- Develop a vocabulary of key terms related to the computer and to software programs.
- Identify the components of a personal computer system.
- Demonstrate mouse and keyboard functions.
- Demonstrate window and menu commands and how they are used.
- Demonstrate how to organize files and documents on a USB/hard drive.
- Send email messages and navigate and search through the internet.

Week	Topics
1.	Data and Information, Information Processing Cycle
2.	Introduction to Computer, Components of a Computer, Advantages and Disadvantages of Using Computers.
3.	Categories of Computers, Computer Applications in Society.
4.	Input Devices: Types of Input, Input for Smart Phones, Game Controllers, Digital Cameras, Voice Input, Video Input, Scanners and Reading Devices, Biometric Input,
5.	Output Devices: Terminals. Display Devices, LCD Monitors and LCD Screens, Plasma Monitors, CRT Monitors,
6.	Printers, Nonimpact Printers, Impact Printers, Speakers, Headphones, Data Projectors. Interactive Whiteboards
7.	Storage Devices: Hard disks, Flash Memory Storage, Solid State Drives, Memory Cards, USB Flash Drives, Cloud Storage, Optical Discs, Blue-Ray Discs, Magnetic Tapes, Magnetic Stripe Cards and Smart Cards, Microfilm and Microfiche, Enterprise Storage.
8.	Programming Languages
9.	Mid Term Exam
10.	CPU: Processor, Control Unit, Arithmetic Logic Unit, Machine Cycle.
11.	Memory: Data Representation, Memory Sizes, Types of Memory, RAM, Cache, ROM, Flash Memory, Primary and Secondary Memory
12.	Software: System Software, Operating Systems, Utility Programs. Application Software, Business Software, Graphics and Multimedia Software, Software for Home, Personal, and Educational Use, Web Applications
13.	Data Communication
14.	Internet , World Wide Web,
15.	Networks , Internet and Searching Techniques, E-Learning, Freelancing
16.	Enterprise Computing, Computer Security Risks, Viruses
17.	Introduction to MS Word, MS Excel, MS PowerPoint
18.	Terminal Examination

NS- 120: AN INTRODUCTION TO PHYSICS

C Hrs: 03

Course outline:

Introduction to Physics: Explore fundamental physics concepts, scientific notations, dimensional analysis, linear relationships and quadratic relationships.

Vectors: Describe types of vectors and the process to add, subtract and multiply vectors. Understand how to get a resultant vector and perform vector operations using components.

Kinematics: Differentiate between displacement and distance and speed and velocity. Determine acceleration using slope of speed and explain projectile, free fall and uniform circular motion.

Force and the Laws of Motion: Examine Newton's Laws of Motion. Explain the differences between mass, inertia and weight and describe action and reaction force pairs. Describe friction, inclined plane, the spring constant and centripetal force.

Work and Energy in Physics: Apply the work-energy theorem and describe relationship between kinetic and potential energy. Examine gravitational potential energy, conservative forces and power.

Linear Momentum in Physics: Describe the impulse-momentum change equation and apply the momentum conservation principle. Discuss elastic and inelastic collisions and isolated systems and find the centre of gravity.

Waves, Sound and Light: Define vibrations and explore wave parameters, electromagnetic waves and pitch and volume in sound waves. Discuss reflection, resonance, color, diffraction and the Doppler Effect.

Thermodynamics in Physics: Explore the relationship between temperature and heat, phase changes and heat transfer. Describe thermal expansion, the ideal gas law, entropy and the first and second laws of thermodynamics.

Electrostatics: Understand electric charge, force fields and Coulomb's Law. Solve parallel-plate capacitor problems and describe electric potential.

Recommended Books

1. College Physics by Raymond A. Serway and Chris Vuille, Volume 10, Publisher: Cengage Learning (2014)
2. University Physics by George Arfken, Academic Press (2012)
3. Fundamentals of Physics by Haliday & Resnick Walker.

QR-101: Basic Mathematics

CHrs: 3

1. Numbers systems

1.1. Real Numbers

1.2. Complex numbers

- The integers
- Rules for addition
- Rules for multiplication
- Even and odd integers; divisibility.
- Rational numbers
- Multiplicative inverses
- Addition and multiplication.
- Real numbers: positivity.
- Powers and roots
- Inequalities
- The complex plane
- Polar form

2. Linear and Quadratic Equations

- Equations in two unknowns
- Equations in three unknowns
- Quadratic Equations

3. Functions

- Definition of a function
- Polynomial functions.
- Graphs of functions
- Exponential function.

4. Determinants Matrices

- Determinants of order
- Properties of 2 X 2 determinants

- Determinants of order 3
- Properties of 3 X 3 determinants

5. Differentiation—Fundamentals

- Derivatives by Definitions
- Power Rule
- Properties of Derivatives
- Product and Division Rules

6. Integration—Fundamentals

- Basic Integrations
- Product Rule

7. GEOMETRY

- Distance and Angles
- The Pythagoras theorem.

7.1. Area and Applications

- Area of a disc of radius r
- Circumference of a circle of radius r

7.2. Coordinates and Geometry

- Coordinate systems
- Distance between points.
- Equation of a circle

7.3. Segments, Rays, and Lines

- Segments
- Rays
- Lines
- Ordinary equation for a line

8. Trigonometry

- Radian measure
- Sine and cosine.
- The graphs.
- The tangent

Reference Book

1. **SERGE LANG**, ADDISON -WESLEY PUBLISHING COMPANY Reading, Massachusetts, Menlo Park, California • London Don Mills, Ontario
2. For basic derivative and integrations follow 2nd year book.

SS-113: Introduction Economics

CHrs:3

Course Objectives

- This course discusses the basic principles of micro and macroeconomics. This course provides the student with a solid grounding in economic principles and familiarize him or her with the institutions and policies that influence economic activity. For those who elect to major in economics, these courses provide the base upon which subsequent courses will build.

- First Introduction to microeconomics studies the economy from the perspective of individual consumers and producers who interact in a market setting. It shows how their choices influence the production and distribution of goods and services and considers the criteria that can be used to assess these outcomes. The course also studies how government intervention can affect the behavior of consumers, producers, and workers and alter market out-comes.
- Second Macroeconomics describes the overall behavior of the economy. In macroeconomics the basic principles of macroeconomics and basic concepts of national income accounting i-e GDP, GNP, NNP, PI, DPI, GDP Deflator etc.
- This also highlights the concepts of money, functions of money, inflation, CPI, impact of inflation on economy and the role of government in an economy

Grading Criteria

Distribution	Weight
Quizzes, Assignments, and class participation	10
Mid Term	20
Final Term	70
Total	100

Recommended Books

- Fundamentals of Economics Part 1 for Intermediate Classes By Habib Ullah Vaseer, edition 2015-2016, Farhan Publishers
- Samuelson and Nordhaus: Economics 19th edition
- Welcome to Economics (McConnell) AP Edition, 19th Edition
- Economic Theory. Vol 2,(2000) by Hussain Ch. M. The carvan press; (Lahore)
- Walter Nicholson: Micro Economics Theories: Basic Principles and Extensions, 10th Edition.
- Mankiw, G–Principles of Economics- latest edition.
- Samulson and Nordrons - Economics –latest edition

CIV-110: Constitutional Law

CHrs:3

Course Contents:

The following concepts shall be covered with special reference to the constitutions of United Kingdom and United States of America:

This course shall cover the nature, sources and fundamental principles of the United Kingdom and the United States Constitutions. The course will examine the remarkable unwritten constitution of the UK, the Separation of Powers, Rule of Law, Parliamentary Supremacy and the Independence of Judiciary under the British constitutional conventions. The course apart from other aspects will cover the concepts of federalism, separation of powers, the functions of the Congress and the legislative procedure, the election of the President and the judicial review under the US Constitution. To understand these concepts with reference to the UK and US constitutions, the following contents order shall be followed:

1. British Political System

- a. Nature of the Constitution
- b. Nature of the Conventions in British Constitution
- c. The Institution of Monarchy: Role, Power & Functions and Importance.
- d. The British Legislature: The Structure and Powers & Functions of the British

- Parliament, the Concept of Parliament Supremacy & Ministerial Responsibility.
 - e. The British Executive; Cabinet and the Prime Minister.
 - f. The Law-Making Process and Rule of Law
 - g. Committee System in UK
 - h. British Judicial System
- 2. US Political System**
- a. Nature of the Constitution
 - b. Nature of the US Federation
 - c. The Theory of Separation of Powers and Check and Balance
 - d. The American Legislature: Structure and Powers & Functions of US Congress.
 - e. The US Executive: Election, Role and Powers & Functions of the US President
 - f. Committee System in US
 - g. The US Supreme Court: Structure and Powers & Functions
 - h. Judicial Review

Suggested Readings

1. Modern Constitutions by Mazhar Ul Haq, 2017
2. America's Constitution by Akhil Reed Amar, 2005
3. World Constitutions by S.L Kelly
4. British Politics by F. N Forman and N. D.J Baldwin, 1991.
5. American Government: Institutions and Politics, 3rd edition by G.Q. Wilson,
6. Parliamentary Government in England by Harold J. Laski, 1960.
7. Political Institutions in Europe by J. M. Colomer, 1996.
8. Major Foreign Powers, New York: Harcourt, Brace & World, INC, 1967.
9. Comparative Constitutional Law by Hamid Khan & M.W. Rana
10. Introduction to the Study of the Law of the Constitution by Dicey
11. Elgar Encyclopedia of Comparative Law by J.M. Smits.

ENG-121: English II: Composition Writing

CHrs:3

The course focuses on the basic strategies of composition and writing skills. Good writing skills not only help students obtain good grades but also optimize their chances to excel in professional life. The course includes modes of collecting information and arranging it in appropriate manner such as chronological order, cause and effect, compare and contrast, general to specific etc. It enables the students to write, edit, rewrite, redraft and proofread their own document for writing effective compositions. Because of the use of a significant amount of written communication on daily basis, sharp writing skills have always been valued highly in academic as well as professional spheres.

Course Contents:

1. Writing Process

- Invention
 - ❖ Generating Ideas (collecting information in various forms such as mind maps, tables, lists, charts etc)
 - ❖ Identifying Audience, Purpose, and Message

Ordering Information

- ❖ Chronology for a narrative
- ❖ Stages of a process
- ❖ From general to specific and vice versa
- ❖ From most important to least important
- ❖ Advantages and disadvantages
- ❖ Comparison and contrast
- ❖ Problem solution pattern

- Drafting
- ❖ Free Writing
- ❖ Revising
- ❖ Editing
- 2. Paraphrasing
- 3. Cohesion and Coherence
 - Cohesive Devices
 - Paragraph unity
- 4. Summary and Precis Writing
- 5. Creative Writing
- 6. Essay Writing
 - ❖ developing a thesis
 - ❖ organizing an essay
 - ❖ writing effective introduction and conclusion
 - ❖ different types of essays
 - ❖ use of various rhetorical modes including exposition, argumentation and analysis

Recommended Books:

- Goatly, A. (2000). *Critical Reading and Writing: An Introductory Course*. London: Taylor & Francis
- Hacker, D. (1992). *A Writer's Reference*. 2nd ed. Boston: St. Martin's
- Hamp-Lyons, L. & Heasley, B. (1987). *Study writing: A course in written English for academic and professional purposes*. Cambridge: Cambridge University Press.
- Howe, D. H, Kirkpatrick, T. A., & Kirkpatrick, D. L. (2004). *Oxford English for Undergraduates*. Karachi: Oxford University Press.

Objectives

This course is aimed:

- ❖ To provide basic information about fundamental beliefs and Pillars of Islam
- ❖ To enhance understanding of the students regarding Quran and Sunnah
- ❖ To inform the students about the practical life of Prophet Muhammad (SAW)
- ❖ To provide the students with the sufficient knowledge about economic, social and cultural systems of Islam
- ❖ To boost up the balanced, enlightened and broad minded information of Islam in students
- ❖ To enable the students for adopting Islamic ethics and moral values
- ❖ To enable the students to live peacefully in a pluralistic and diversified society
- ❖ To promote the feelings of human sympathy in students without the condition of race or religion

Course Contents

1. Study of Fundamental Religious Beliefs & Practices

1.1 Islamic Beliefs:

- i. Importance of Beliefs in personality building (general discussion)
- ii. Study of the Islamic Beliefs: (Beliefs in Almighty Allah, Angles, Revealed Books, Prophet hood as well as Finality of Prophet hood, Destiny, Day of Judgment (Resurrection), desired effects of Islamic beliefs on Individual and Society)

1.2 Practices (Ibadaat) of Islam

Philosophical Study of *Ibadaat*:

- i. Definition and Scope of *Ibadah*
- ii. Physical Submissions i.e. prayer and fasting : its rationale and its desired effects on Individual and society
- iii. Financial Submissions i.e. Zakat and alms giving: its rationale and its desired effects on Individual and society

- iv. Collective Submissions [Physical cum Financial] i.e. performing Hajj and Umarh: its rationale and its desired effects on Individual and society
- v. Scope of chain of various *Ibadah*

2. Study of Basic Sources of Religion

2.1 Study of Quran:

- i. Sources of Knowledge
- ii. Need for Revelation
- iii. Division of Surahs in Makki and Madani Titles
- iv. Brief introduction of various kinds of Ayaa (verses) i.e. Ayaat ul Ahkaam, Ayaat Anfusi, Ayaat Kawnia.
- v. Special focus on the behavior of Qura'n with other divine books and prophets in the lights of Qura'nic texts
- vi. Textual & Thematic Study of Holy Quran:
 - a. Surah Hujarat (Complete) with special focus on ethics and morality
 - b. Surah Israa verses 23-40 with special focus on ethics and morality

2.2 Study of Sunnah:

- i. Meaning of Hadith & Sunnah and its kinds (Qawli, Feli, Taqreeri)
- ii. Need, Importance of Hadith and its authority
- iii. Important Books of Hadith (*Sihah Sitta* and *Kutub-e-Arbah*)
- iv. Textual & Thematic Study of Hadith: Study of 20 Selected Hadiths (attached as Annex-1)

3. Brief Study of Biography of Prophet Muhammad (SAW)

- 3.1 Year wise Summary of Prophet's Life
- 3.2 Lessons learnt from life at Makkah
- 3.3 Lessons learnt from His life at Madinah with special reference to pact of Madina and Hudaibiyyah
- 3.4 *Hijrat*(Migration): its philosophy in general, causes and results
- 3.5 Jihad: Definition, Philosophy, justification (with special reference to *Badr*, *Uhad* and *Khandaq*)

4. Study of Islam in Multi-dimensional Aspects

- 4.1 Cultural and Social System of Islam: Introduction of Society and Culture, Salient features of Islamic culture and Society

- 4.2 Economic System of Islam: Basic concepts of Islamic economic system, Means of distribution of wealth in Islam
 - 4.3 Political System of Islam: Basic concepts of Islamic political system, Qualities of Islamic political System
- 5. Pluralism, Diversity and Islam**
- 5.1 Introduction of Pluralism and diversity, with special reference to diversity in Universe
 - 5.2 Diversity in humans (personalities, gender, interests, hobbies, languages etc.)
 - 5.3 Religious diversity, with special focus on various religions and sects
- 6. Human Rights and Islam**
- 6.1 Concept and significance
 - 6.2 Human Rights in Islam
 - 6.3 Human Rights in the constitution of Pakistan
 - 6.4 Human Rights in UNO Charter
- 7. Peace Education and Conflict Resolution**
- 7.1 Peace: Concept, its significance in personal, domestic, social, national and International level
 - 7.2 Religious instructions regarding peace in various dimensions of life
 - 7.3 Conflict: Reasons and Stages of conflict, Reconciliation
 - 7.4 Role of Communication in Peace building: Concept of Communication, Effective Communication, Rehabilitation of peace through communication
 - 7.5 The role of inter and intra faith dialogue in maintaining peace as well as religious Harmony on national and international level

Recommended Books

1. Hamidullah, Dr. (2000), *Introduction to Islam*, Dawah Academy, Islamabad
2. Khan, Rafique Ali(2001), *Freedom of Thought in Islam*, Royal Book Company, Karachi
3. Ali, Syed Amir (2009), *The Spirit of Islam*, Islamic Book Service, Lahore
4. Hamidullah, Dr. (2005), *Muhammad Rasulullah: A concise survey of the life and work of the founder of Islam*, Dawah Academy, Islamabad

5. Hamidullah, Dr. (2000), *Islamic Notion of conflict of Laws*, Dawah Academy, Islamabad
6. UNO Charter of International Human Rights of 1948

ENG-231:English III: Communication and Presentation Skills CHrs: 3

Description:

For professional growth and future development, effective presentation skills and interactive and interpersonal communicative skills are very important. This course offers methods, techniques, and drills significant and useful in optimising communication and presentation skills of the learners, enabling them to face divergent groups of audience with poise and confidence. The course has been divided into modules relating to the essentials, contents, gestures, technology, and variety associated with communication and presentations skills. The presentation skills part focuses on preparing students for long-life skill of preparing and giving presentations. Communication is a vital part of our daily routine. The communication skills part focuses on developing good communication skills among students.

Course Contents

1. Introduction
 - Components of Communication
 - Types of Communication
 - Understanding the purpose of Communication
 - Analyze the Audience
 - Communicating with words as well as with body language
 - Writing with a Purpose
 - Barriers to Communication
2. Presentation skills
3. Delivering your presentation
4. Speaking with Confidence
5. Communicating Effectively
6. Job Interviews and Communicating Skills
7. Communicating with Customers
8. Communication in a Team

Recommended Readings:

1. Carnegie, Dale. (). *How to Win Friends & Influence People*.
2. Giblin, Les. *Skill with People*.
3. Newton, Paul. *How to communicate effectively*.

PHY- 101: Mechanics-I

CHrs: 03

Course outline:

Review of Newtonian Mechanics: Frame of reference, orthogonal transformations, angular velocity and angular acceleration, Newton's laws of motion, Galilean transformation, conservation laws, systems of particles, motion under a constant force, motions under variable force, time-varying mass system.

The Lagrange Formulation of Mechanics and Hamilton Dynamics: Generalized co-ordinates and constraints, D-Alembert's principle and Lagrange's Equations, Hamilton's principle, integrals of motion, non-conservative system and generalized potential, Lagrange's multiplier method, the Hamiltonian of a dynamical system, canonical equations, canonical transformations, Poisson brackets, phase space and Liouville's theorem.

Central Force Motion: The two-body problem, effective potential and classification of orbits, Kepler's laws, stability of circular orbits, hyperbolic orbits and Rutherford scattering, center of mass co-ordinate system, scattering cross-sections.

Motion in Non- inertial Systems: Accelerated translational co -ordinate system, dynamics in rotating co-ordinate system, motion of a particle near the surface of the earth.

The Motion of Rigid Bodies: The Euler angles, rotational kinetic energy and angular momentum, the inertia tensor, Euler equations of motion, motion of a torque-free symmetrical top, stability of rotational motion.

Recommended Books:

3. T. L. Chow, "Classical Mechanics", John Wiley, 1995.
4. T. Kibble and F. Berkshire, "Classical Mechanics", World Scientific, 5th ed. 2004.C
5. Classical Mechanics, H. Goldstein, 3rd Ed., Addison Wesley Reading, Massachusetts, 2006
6. Classical Dynamics of Particles and System, Jerry B. Marian, Stephen T.
7. Thornton, 4th Ed., Harcourt Brace & Company, 1995
8. Classical Mechanics, A. Douglas Davis, Academics Press, 1986

TEXT/REFERENCE BOOKS/WEBSITES LINKS:

Text Books:

1. Shelly, G. B., & Vermaat, M. E. (2012). *Discovering computers fundamentals: your interactive guide to the digital world (Latest ed.)*. Cengage Learning.

Reference Books:

1. Sawyer, S. C., & Williams, B. (2000). *Introduction to Using Information Technology (Latest ed.)*. McGraw-Hill Higher Education
2. Brookshear, G. G., & Brookshear, J. G. (2002). *Computer science: an overview (Latest ed.)*. Addison-Wesley Longman Publishing Co., Inc.

Website Links:

1. https://www.tutorialspoint.com/computer_fundamentals/index.htm
2. <https://codescracker.com/computer-fundamental/>

PHY- 311: Mechanics-II**CHrs: 03****Course Contents:**

Review of Newtonian Mechanics: Frame of reference, orthogonal transformations, angular velocity and angular acceleration, Newton's laws of motion, Galilean transformation, conservation laws, systems of particles, motion under a constant force, motions under variable force, time-varying mass system.

The Lagrange Formulation of Mechanics and Hamilton Dynamics: Generalized co-ordinates and constraints, D'Alembert's principle and Lagrange's Equations, Hamilton's principle, integrals of motion, non-conservative system and generalized potential, Lagrange's multiplier method, the Hamiltonian of a dynamical system, canonical equations, canonical transformations, Poisson brackets, phase space and Liouville's theorem.

Central Force Motion: The two-body problem, effective potential and classification of orbits, Kepler's laws, stability of circular orbits, hyperbolic orbits and Rutherford scattering, center of mass co-ordinate system, scattering cross-sections.

Motion in Non- inertial Systems: Accelerated translational co -ordinate system, dynamics in rotating co-ordinate system, motion of a particle near the surface of the earth.

The Motion of Rigid Bodies: The Euler angles, rotational kinetic energy and angular momentum, the inertia tensor, Euler equations of motion, motion of a torque-free symmetrical top, stability of rotational motion.

Recommended Books:

1. T. L. Chow, "Classical Mechanics", John Wiley, 1995.
2. T. Kibble and F. Berkshire, "Classical Mechanics", World Scientific, 5th ed. 2004.
3. Classical Mechanics, H. Goldstein, 3rd Ed., Addison Wesley Reading, Massachusetts, 2006
4. Classical Dynamics of Particles and System, Jerry B. Marian, Stephen T. Thornton, 4th Ed., Harcourt Brace & Company, 1995
5. Classical Mechanics, A. Douglas Davis, Academic Press, 1986

PS:321: Pakistan Studies**CHrs:3****Course Contents:**

Introduction/Objectives:

To develop vision of historical perspective, government, politics,

Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

Course Outline**1. Historical Perspective**

- a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah.
- b. Factors leading to Muslim separatism
- c. People and Land
 - i. Indus Civilization
 - ii. Muslim advent

iii. Location and geo-physical features.

1. Government and Politics in Pakistan

Political and constitutional phases:

- a. 1947-58
- b. 1958-71
- c. 1971-77
- d. 1977-88
- e. 1988-99
- f. 1999 onward

3. Contemporary Pakistan

- a. Economic institutions and issues
- b. Society and social structure
- c. Ethnicity
- d. Foreign policy of Pakistan and challenges
- e. Futuristic outlook of Pakistan

Recommended Books:

1. Afzal, M. Rafique. Political Parties in Pakistan, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998
2. Akbar, S. Zaidi. Issue in Pakistan's Economy. Karachi: Oxford University Press, 2000.
3. Amin, Tahir. Ethno - National Movement in Pakistan, Islamabad: Institute of Policy Studies, Islamabad.
4. Aziz, K.K. Party, Politics in Pakistan, Islamabad: National Commission on Historical and Cultural Research, 1976.
5. Burki, Shahid Javed. State & Society in Pakistan, the Macmillan Press Ltd 1980.
6. Haq, Noor ul. Making of Pakistan: The Military Perspective. Islamabad: National Commission on Historical and Cultural Research, 1993.
7. Mehmood, Safdar. Pakistan Kayyun Toota, Lahore: Idara-e- Saqafat-e-Islamia, Club Road, nd.
8. Mehmood, Safdar. Pakistan Political Roots & Development. Lahore, 1994.
9. Muhammad Waseem, Pakistan Under Martial Law, Lahore: Vanguard, 1987.
10. S.M. Burke and Lawrence Ziring. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press, 1993.
11. Sayeed, Khalid Bin. The Political System of Pakistan. Boston: Houghton Mifflin, 1967.
12. Wilcox, Wayne. The Emergence of Bangladesh., Washington: American Enterprise, Institute of Public Policy Research, 1972.
13. Zahid, Ansar. History & Culture of Sindh. Karachi: Royal Book Company, 1980.
14. Ziring, Lawrence. Enigma of Political Development. Kent England: WmDawson & sons Ltd, 1980.

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-211	CALCULUS-I	MATHEMATICS AT INTERMEDIATE LEVEL

SPECIFIC OBJECTIVES OF THE COURSE:

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

COURSE OUTLINE:

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

Functions and graphs: Domain and range of a function. Examples: polynomial, rational, piecewise defined functions, absolute value functions, and evaluation of such functions.

Operations with functions: sum, product, quotient and composition. Graphs of functions

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

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

Derivatives: Definition, techniques of differentiation. Derivatives of polynomials and rational, exponential, logarithmic and trigonometric functions. The chain rule. Implicit differentiation. Related rates. Linear approximations and differentials. Higher derivatives, Applications of derivatives: Increasing and decreasing functions. Relative extrema and optimization. First derivative test for relative extrema. Convexity and point of inflection. The second derivative test for extrema. Curve sketching. Mean value theorems. Indeterminate forms and L'Hopitals rule. Inverse functions and their derivatives.

Integration: Anti derivatives and integrals. Riemann sums and the definite integral, properties of Integral, the fundamental theorem of calculus, the substitution rule.

Recommended Books

1. J Stewart, Calculus (7th edition), Brooks/Cole 2011
2. Thomas, Calculus, 11th Edition. Addison Wesley Publishing Company, 2005
3. H. Anton, I. Bevens, S. Davis, "Calculus, (Early Transcendental)", (9th edition), John Wiley, New York, 2009.

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-212	SET THEORY AND MATHEMATICAL LOGICS	CALCULUS-I

SPECIFIC OBJECTIVE OF COURSE:

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

propositional and predicate logics.

COURSE OUTLINE:

Set theory: Sets, subsets, operations with sets: union, intersection, difference, symmetric difference, Cartesian product and disjoint union. Functions: graph of a function, composition; injections, surjection, bijections, inverse function.

Computing cardinals: Cardinality of Cartesian product, union, cardinality of all functions from a set to another set. Cardinality of all injective, surjective and bijective functions from a set to another set. Infinite sets, finite sets, countable sets, properties, examples (Z, Q). R is not countable. R, R x R, R x R x R have the same cardinal, operations with cardinal numbers, cantor-Bernstein theorem.

Relations: Equivalence relations, partitions, quotient set; examples, parallelism, similarity of triangles. Order relations, min, max, inf, sup; linear order. Examples: N, Z, R, P(A). Well-ordered sets and induction, inductively ordered sets and Zorn's lemma.

Mathematical logic: Propositional calculus, truth tables, predicate calculus.

Recommended Books

1. M. Liebeck, A Concise Introduction to Pure Mathematics, CRC Press, 2011.
2. N. L. Biggs, Discrete Mathematics, Oxford University Press, 2002.
3. R. Garnier, J. Taylor, Discrete Mathematics, Chapters 1,3,4,5, CRC Press, 2010.
4. A.A. Fraenkal, Abstract Set Theory, North-Holland Publishing Company, 1966.

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-213	NUMBER THEORY	CALCULUS I, DISCRETE MATHEMATICS

SPECIFIC OBJECTIVE OF COURSE:

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

COURSE OUTLINE:

Preliminaries: Well-ordering principle. Principle of finite induction.

Divisibility theory: The division algorithms. Basis representation theorem. Prime and composite numbers. Canonical decomposition. The greatest common divisor. The Euclidean algorithm. The fundamental theorem of arithmetic. Least common multiple.

Linear Diophantine equations: Congruence's. Linear congruence's. System of linear congruence's. The Chinese remainder theorem. Divisibility tests. Solving polynomial congruencies. Fermat's and Euler's theorems. Wilson's theorem.

Arithmetic functions: Euler's phi-function. The functions of J and sigma. The Mobius function. The sieve of Eratosthenes. Perfect numbers. Fermat and Mersenne primes.

Primitive Roots and Indices: The order of integer mod n. Primitive roots for primes. Composite numbers having primitive roots.

Recommended Books

1. D.M. Burton, Elementary Number Theory, McGraw-Hill, 2007.
2. S.B. Malik, Basic Number Theory, Vikas Publishing house, 1995.
3. K.H. Rosen, Elementary Number Theory and its Applications, 5th edition.

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-221	CALCULUS-II	CALCULUS-I
<p>SPECIFIC OBJECTIVES OF THE COURSE: This is the second course of the basic sequence Calculus I-III serving as the foundation of advanced subjects in all areas of mathematics. The sequence, equally, emphasizes basic concepts and skills needed for mathematical manipulation. As continuation of Calculus-I, it focuses on the study of functions of a single variable.</p> <p>COURSE OUTLINE: Techniques of integration: Integrals of elementary, hyperbolic, trigonometric, logarithmic and exponential functions. Integration by parts, substitution and partial fractions. Approximate integration. Improper integrals. Gamma functions. Applications of integrals: Area between curves, average value, volumes, arc length, area of a surface of revolution. Infinite series: Sequences and series. Convergence and absolute convergence. Tests for convergence, divergence test, integral test, p-series test, comparison test, limit comparison test, alternating series test, ratio test, roots test. Power series. Convergence of power series. Representation of functions as power series. Differentiation and integration of power series. Taylor and McLaurin series. Approximations by Taylor polynomials. Conic section, parameterized curves and polar coordinates: Curves defined by parametric equations. Calculus with parametric curves: tangents, areas, arc length. Polar coordinates. Polar curves, tangents to polar curves. Areas and arc length in polar coordinates.</p>		
<p>Recommended Books</p> <ol style="list-style-type: none"> 1. Thomas, Calculus, 11th Edition. Addison Wesley Publishing Company, 2005 2. H. Anton, I. Bevens, S. Davis, "Calculus, (Early Transcendental)", (9th edition), John Wiley, New York, 2009. 3. J Stewart, Calculus (7th edition), Brooks/Cole 2011 		

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-218	ALGEBRA-I	
<p>SPECIFIC OBJECTIVES OF COURSE: This course introduces basic concepts of groups and their homomorphisms. The main objective of this course is to prepare students for courses which require a good back ground in group theory like Rings and Modules, Linear Algebra, Group Representation, Galois Theory etc.</p> <p>COURSE OUTLINE: GROUPS: Definitions and Consequences, Subgroups, Relations Between Groups, Cyclic Groups, Groups and Symmetries, Exercises*</p> <p>EXMAPLEXES IN GROUPS: Complexes and Cosets, Decomposition of a Group, Lagrange's Theorem, Normalizers and Centralizers, Conjugacy Relations in Groups, Double Cosets, Exercises*</p>		

SUBGROUPS, FACTOR GROUPS: Normal Subgroups, Quotient/Factor Groups, Automorphism Group of a Group, Commutator or Derived Subgroup, Characteristic and Fully Invariant Subgroups, Exercises*

GROUPS OF PERMUTATIONS: Symmetric or Permutation Groups, Per-mutability of Permutations, Cyclic Permutations and Orbits, Order of a Permutations, Transpositions, Even and Odd Permutations, Exercises*

Note: * is used for few and related exercises.

Recommended Books

1. Dr. Abdul Majeed. "Theory of Groups", Latest Edition (2012), ILMI KITAB KHANA
2. J. Rose, A Course on Group Theory, Cambridge University Press, 1978.
3. J. B. Fraleigh, A First Course in Abstract Algebra, Addison Wesley Publishing Company, 2002.

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-223	BASIC TOPOLOGY	CALCULUS-I
SPECIFIC OBJECTIVE OF COURSE:		
The aim of this course is to introduce the students to metric spaces and topological spaces. They would be able to determine whether a function defined on a metric or topological space is continuous or not.		
COURSE OUTLINE:		
Metric Space, Examples of metric spaces, Open balls, Topological Space and different types of topological spaces, Open and Closed sets, Interior points, Exterior points, Boundary points, Closure of a set, Limit points, Neighborhoods and Neighborhood system, Subspace Topology, Bases and sub-bases, Continuous functions and Homeomorphisms.		
Recommended Books		
<ol style="list-style-type: none"> 1. C. Wayne Patty; Foundations of Topology, 2nd Edition. 2. A. Majeed; Elements of Topology and Functional analysis, Ilmikitabkhana, 1990. 3. H. Anton, C. Rorres , Elementary Linear Algebra: Applications Version, 10th Edition, John Wiley and sons, 2010. 		

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-219	ORDINARY DIFFERENTIAL EQUATION	CALCULUS-I
SPECIFIC OBJECTIVE OF COURSE:		
To introduce students to the formulation, classification of differential equations. To provide skill in solving first order and second order linear homogeneous and non-homogeneous differential equations and solving initial and boundary value problems.		

COURSE OUTLINES:

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

First order ordinary differential equations: Basic concepts, formation and solution of differential equations, Separation of variables, Homogeneous equations, Exact equations, Solution of linear equations by integrating factor, Some special non-linear first order differential equations like Bernoulli's equations Ricatti equations and Clairaut equations, Basic theory of system of first order linear differential equations, Homogeneous linear system with constant coefficients.

Second and higher order linear differential equations: Initial value and boundary value problems, linearly independence and Wronskian, Superposition principle, Homogeneous and non-homogeneous equations, Reduction of order, Solution of homogeneous equations with constant coefficients, Particular solution of non-homogeneous equations, Method of Undetermined coefficients, Variation of parameters and Cauchy-Euler equations

Recommended Books

1. Dennis G. Zill and Michael R., Differential equations with boundary-value problems by Cullin 5th Edition Brooks/Cole, 1997.
2. William E. Boyce and Richard C. Diprima, Elementary differential equations and boundary value problems, Seventh Edition John Wiley & Sons, Inc
3. V. I. Arnold, Ordinary Differential Equations, Springer, 1991.
4. T. Apostol, Multi Variable Calculus and Linear Algebra, 2nd ed., John Wiley and sons, 1997.

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-316	REAL ANALYSIS-I	CALCULUS-III
<p>SPECIFIC OBJECTIVES OF COURSE: This is the first course in analysis. It develops the fundamental ideas of analysis and is aimed at developing the students' ability in reading and writing mathematical proofs. Another objective is to provide sound understanding of the axiomatic foundations of the real number system.</p> <p>COURSE OUTLINES: Ordered fields, Rational, real and, Archimedean property, supremum, infimum and completeness, sequences, subsequences, Monotone sequences, Limits of sequences, algebra of limits, squeeze theorem, bounded sequences, Bolzano Weierstrass Theorem. Cauchy sequences, Functions, limits of functions, limit theorems, continuous functions, combinations of continuous functions, uniform continuity. Continuity Intermediate mean value theorem, Monotone functions and discontinuities.</p>		
Recommended Books		
<ol style="list-style-type: none"> 1. Robert G. Bartle, Donald R. Sherbert; Introduction to Real analysis (Third edition), John Wiley & sons 2005. 2. S. Lang, Analysis I, Addison-Wesley Publ. Co., Reading, Massachusetts, 1968. 3. K. R. Davidson and A. P. Donsig, Real Analysis with Real Applications, Prentice Hall 		

- Inc., Upper Saddle River, 2002.
4. G. B. Folland, Real Analysis, 2nd Edition, John Wiley and Sons, New York, 1999.

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-311	AFFINE AND EUCLIDEAN GEOMETRY	CALCULUS-I

SPECIFIC OBJECTIVES OF COURSE:

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

COURSE OUTLINE:

Vector spaces and affine geometry: Collinearity of three points, ratio AB/BC . Linear combinations and linear dependent set versus affine combinations and affine dependent sets. Classical theorems in affine geometry: Thales, Menelaus, Ceva, Desargues. Affine subspaces, affine maps. Dimension of a linear subspace and of an affine subspace. Euclidean geometry: Scalar product, Cauchy-Schwartz inequality: norm (magnitude) of a vector, distance between two points, angles between two non-zero vectors. Pythagoras theorem, parallelogram law, cosine and sine rules. Elementary geometric loci. Orthogonal transformations: Isometries of plane (four types), Isometries of space (six types). Orthogonal bases. Platonic polyhedra: Euler theorem on finite planar graphs. Classification of regular polyhedral in space. Isometries of regular polygons and regular polyhedra.

Recommended Books

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

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-314	GENERAL TOPOLOGY	BASIC TOPOLOGY

SPECIFIC OBJECTIVES OF COURSE:

This course is a continuation of topics in Topology. After completion of this course, they would be familiar with separation axioms, compactness and connectedness.

COURSE OUTLINE:

T_0 spaces, T_1 spaces and Hausdorff spaces, Regular and completely regular spaces, normal spaces, Compact topological spaces, properties of compact spaces, finite intersection property, local compactness, Connected topological spaces, properties of connected spaces.

Recommended Books

1. C. Wayne Patty; *Foundations of Topology*, 2nd Edition.

2. A.Majeed; Elements of Topology and Functional analysis, Ilmikitabhana, 1990.

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-317	DIFFERENTIAL GEOMETRY	CALCULUS-I+ LINEAR ALGEBRA
SPECIFIC OBJECTIVES OF COURSE:		
After having completed this course, the students would be expected to understand classical concepts in the local theory of curves and surfaces including normal, principal, mean, curvature, and geodesics.		
COURSE OUTLINE:		
Theory of Space Curves: Introduction, index notation and summation convention. Space curves, arc length, tangent, normal and binormal. Osculating, normal and rectifying planes. Curvature and torsion. The Frenet-Serret theorem. Natural equation of a curve. Involutives, evolutes and helices. Fundamental existence theorem of space curves.		
Theory of Surfaces: Coordinate transformation. Tangent plane and surface normal. The first fundamental form. The second fundamental form. Principal, Gaussian, mean, geodesic and normal curvatures. Gauss and Weingarten equations. Gauss and Codazzi equations.		
Recommended Books		
<ol style="list-style-type: none"> 1. R. S. Millman and G. D. Parker, Elements of Differential Geometry, Prentice-Hall, New Jersey, 1977. 2. A. Goetz, Introduction to Differential Geometry, Addison Wesley, 1970. 3. E. Kreyzig, Differential Geometry, Dover, 1991. 4. M. M. Lipschutz, Schaum's Outline of Differential Geometry, McGraw Hill, 1969. 		

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-315	COMPUTATIONAL TOOLS FOR MATHEMATICIANS	INTRODUCTION TO COMPUTER
The purpose of this course is to teach students the use of mathematical software like MATLAB, MATHEMATICA for solving computationally-difficult problems in mathematics. The student shall become well versed in using at least one mathematical software and shall learn several techniques that are useful in calculus as well as in other areas of mathematics.		
COURSE OUTLINE:		
Use of mathematical software like Matlab and Mathematica for numerical calculations, graphics, algebra and calculus, solving equation, matrices, symbolic calculations, input and output, mathematical functions, power series, linear algebra etc.		
Recommended Books		
<ol style="list-style-type: none"> 1. Etter DM, Kuncicky D, Hull D, Introduction to MATLAB 6, 2001, Prentice Hall, Englewood Cliffs, NJ, USA 2. Garvan F, The Maple Book, 2002, Champan & Hall/CRC 3. Kaufmann S, Mathematics As a Tool: An Introduction with Practical Examples, 1994, Springer, New York 		

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-321	REAL ANALYSIS-II	REAL ANALYSIS-I
<p>SPECIFIC OBJECTIVES OF COURSE: A continuation of Real Analysis I, this course will continue to cover the fundamentals of real analysis concentrating on the Differentiation of functions, Riemann integrals, Improper Integrals, and Emphasis would be on proofs of main results.</p> <p>COURSE OUTLINE: Differentiation, Mean Value Theorem, L'Hopital Rule, Taylor's Theorem, The Riemann Integral, Riemann Integrable functions. The Fundamental theorem of calculus. Improper Integrals Types of improper integrals, tests for convergence of improper integrals. Beta and gamma functions. Absolute and conditional convergence of improper integrals.</p> <p>Recommended Books</p> <ol style="list-style-type: none"> 1. G. Bartle , R. Sherbert , Introduction to Real Analysis, 3rd edition, John Wiley, New York, 1999. 2. S. Lang, Analysis I, II, Addison-Wesley Publ. Co., Reading, Massachusetts, 1968, 1969. 3. K. R. Davidson and A. P. Donsig, Real Analysis with Real Applications, Prentice Hall Inc., Upper Saddle River, 2002. 4. G. B. Folland, Real Analysis, 2nd Edition, John Wiley and Sons, New York, 1999 		

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-322	COMPLEX ANALYSIS	REAL ANALYSIS-I
<p>SPECIFIC OBJECTIVES OF 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.</p> <p>COURSE OUTLINE: Analytic Function: Function of a Complex variable, Limits, Theorems on limits. Continuity, Differentiation, Cauchy-Riemann conditions, sufficient conditions, Analytic functions, Harmonic functions. L. Hospital's Rule. Singular points and their types. Integrals: Definite Integrals, Contours, Line Integrals, Simply and multiply connected regions, Cauchy integral theorem, Cauchy-Goursat theorem for the case of triangle, closed polygon, simple closed curve and Multiply connected, Derivatives of analytic functions, Morera's theorem, Cauchy inequality, Liouville's theorem, fundamental theorem of Algebra, Maximum and Minimum modulus theorems, Rouché's theorem. Residues and Poles: Residues, Residue theorem, poles, quotients of analytic functions, Cauchy principal value of integrals, improper integrals involving Trigonometric functions, Definite integral of Trigonometric functions, and integration around a branch point.</p> <p>Recommended Books</p>		

1. Dennis G. Zill, Patrick D. Shanahan, "A first course in complex analysis with applications" National book foundation Islamabad.
2. R. V. Churchill & J.W. Brown "Complex Variable and Applications"(7th edition) (McGraw-Hill), 2003.

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-323	MATHEMATICAL METHODS	CALCULUS III

SPECIFIC OBJECTIVES OF COURSE:

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

COURSE OUTLINE:

Fourier Methods: The Fourier transforms. Fourier analysis of the generalized functions. The Laplace transforms. Hankel transforms for the solution of PDEs and their application to boundary value problems.

Green's Functions and Transform Methods: Expansion for Green's functions. Transform methods. Closed form Green's functions. Perturbation Techniques: Perturbation methods for algebraic equations. Perturbation methods for differential equations.

Variational Methods: Euler-Lagrange equations. Integrand involving one, two, three and n variables. Special cases of Euler-Lagrange's equations. Necessary conditions for existence of an extremum of a functional. Constrained maxima and minima.

Recommended Books

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

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-324	GROUP THEORY	SET THEORY AND MATHEMATICAL LOGIC

SPECIFIC OBJECTIVES OF COURSE:

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

COURSE OUTLINE:

Definition of a group, subgroup. The cyclic groups, cosets and Lagrange's theorem, normalize,

centralizer, the center of a group, equivalence relation in a group, conjugacy classes. normal subgroups, quotient group. Group homomorphism's: Homomorphism and isomorphism and automorphism, kernel and image of homomorphism. Isomorphism theorems. Permutation groups. The cyclic decomposition of a permutation group. Cayley's theorem.

Recommended Books

1. J. Rose, A Course on Group Theory, Cambridge University Press, 1978.
2. P. M. Cohn, Algebra, John Wiley and Sons, London, 1974.
3. J. B. Fraleigh, A First Course in Abstract Algebra, AddisonWesley Publishing Company, 2002.
4. A. Majeed, "Theory of Groups", Ilmi Kitab Khana
5. V. K. Khanna,S.K.Bhambri " A Course in Abstract Algebra" (3rd edition),1995

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-325	RINGS AND FIELD	
Basic concepts of Rings, subrings, Characteristics of a ring, Ideals, Quotients Rings, Ring Homomorphism, Isomorphism Theorems, imbedding of rings, Factorization theory, Euclidean domain, prime & irreducible elements, Polynomial rings & irreducibility criterion, Unique factorization domain, algebraic extensions, roots of polynomials, splitting field, Finite fields.		
Recommended Books		
<ol style="list-style-type: none"> 1. J.A.Fraleigh, "A First Course in Abstract Algebra", Addison Wesley publishing Company, 1982. 2. I.N.Herrnstein, "Topics in Algebra" John Wiley & Sons, 1975. 3. S.Lang., "Algebra". Addison Wesley, 1965. 4. B.Hartley, T.O.Hawke's, "Rings Modules and Linear Algebra", Chapman and Hall, 1980. 		

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-411	FUNCTIONAL ANALYSIS-I	GENERAL TOPOLOGY
SPECIFIC OBJECTIVES OF COURSE:		
This course extends methods of linear algebra and analysis to spaces of functions, in which the interaction between algebra and analysis allows powerful methods to be developed. The course will be mathematically sophisticated and will use ideas both from linear algebra and analysis.		
COURSE OUTLINES:		
Metric Spaces: Further Examples of metric spaces, Open set, closed set, neighborhood, convergence, Cauchy sequences, completeness, Examples- completeness proofs, completion of metric spaces,		
Normed Spaces, Banach space : Vector space, Normed space, Banach space, Further properties of Normed spaces, Finite dimensional Normed spaces and subspaces, Compactness and finite dimension, Linear operators, bounded and continuous linear operators, Linear functionals, Linear operators and functionals on finite dimension spaces, Normed spaces of operators, dual space.		
Recommended Books		
<ol style="list-style-type: none"> 1. E. Kreyszig, Introductory functional Analysis with applications, John Wiley and sons 1978. 		

2. A. E. Taylor and D. C. Lay, Introduction to Functional Analysis, John Wiley & sons, 1980
3. G. F. Simmons, Introduction to topology and Modern Analysis, (Revised Edition) McGraw Hill Book Company.
4. R. F. Ourtain, A. J. Pritchard, Functional Analysis in Modern Applied Mathematics, Academic, Press, New York.
5. A. Friechmen, Foundations of Modern Analysis, 1982, Dover

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-412	NUMERICAL ANALYSIS-I	CALCULUS-I

SPECIFIC OBJECTIVES OF COURSE:

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

COURSE OUTLINE:

Errors, Relative error, Absolute error, inherent error, round-off error, truncation error, significant digits and numerical instability, Bisection method with examples, Secant and Regula- Falsi methods with examples, Newton- Raphson method with examples, Rate of convergence of Secant method, Regula Falsi method and Newton-Raphson Method, Partial pivoting, complete pivoting, Gauss elimination method with examples, Gauss-Jordan Elimination Method with examples, Triangularization Method, Doolittle's method. Crout's method, Cholesky method with examples, Jacobi iteration method with examples, Gauss-Seidel Iteration method with examples, Successive over relaxation method(SOR) method with examples, Iterative method to determine the inverse of a matrix (\mathbf{A}^{-1}), Eigenvalues and Eigenvectors, Faddeev-Leverrier method with examples, Power method with examples and inverse power method with examples, Taylor Series, interpolation, Lagrange and Newton Interpolations, Linear Interpolation. Lagrange interpolation, Newton's Divided difference interpolation, iterated interpolation, Newton's divided difference interpolation, finite difference operators with examples.

Recommended Books

- 1 C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, Singapore, 2005.
- 2 R. L. Burden and J. D. Faires: Numerical Analysis, latest edition, PWS Pub. Co.
- 3 MK Jain, SRK Iyengar, RK Jain, Numerical Methods for scientific and engineering computation 6th edition, New age international Publishers
- 4 S. C. Chapra and R. P. Canale: Numerical Methods for Engineers, 6th edition, McGraw

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-413	INTEGRAL EQUATIONS	ODE

SPECIFIC OBJECTIVES OF COURSE:

Many physical problems that are usually solved by differential equation methods can be solved

more effectively by integral equation methods. This course will help students gain insight into the application of advanced mathematics and guide them through derivation of appropriate integral equations governing the behavior of several standard physical problems.

COURSE OUTLINE:

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

Recommended Books

- 1 Lovitt, W.V., Linear integral equations, Dover Publications 1950.
- 2 Smith, F., Integral equations, Cambridge University Press.
- 3 Tricomi, F.G., Integral equations, Interscience, 1957.
- 4 B. Noble., Methods based on the Wiener-Hopf technique, Pergamon Press, 1958.
- 5 Abdul J. Jerri., Introduction to integral equations with applications, Marcel Dekker Inc. New York, 1985.

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-421	NUMERICAL ANALYSIS-II	NUMERICAL-I ANALYSIS

SPECIFIC OBJECTIVES OF THE COURSE:

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

COURSE OUTLINE:

Numerical differentiation, Methods based on interpolation, non-Uniform nodal points, linear interpolation, Quadratic interpolation, Uniform nodal points. Linear interpolation, quadratic interpolation, method based on finite differences, Method based on undetermined coefficients, extrapolation methods, Numerical integration, methods based on interpolation, Newton-Cotes methods, open type integration rules, Gauss Quadrature methods, Gauss-Legendre Integration Method, Gauss-Chebyshev integration Methods, Composite integration methods, Trapezoidal rule, Simpson’s rule, ordinary differential equations, initial value problems, Reduction of higher order equations to the system of first order differential equations, existence and uniqueness, system of first order differential equations with constant coefficients with examples, numerical methods, local truncation error, convergence, stability, Euler method with examples, Backward Euler Method with examples, Mid-point method, Taylor Series method, Runge Kutta Methods, Explicit Runge kutta Method, second order methods, Third order Methods, fourth order methods, Runge kutta method for system of two equations, Shooting method for second order linear differential equations

Recommended Books

- 1 C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, Singapore, 2005.

- 2 R. L. Burden and J. D. Faires: Numerical Analysis, latest edition, PWS Pub. Co.
- 3 MK Jain, SRK Iyengar, RK Jain, Numerical Methods for scientific and engineering computation 6th edition, New age international Publishers
- 4 S. C. Chapra and R. P. Canale: Numerical Methods for Engineers, 6th edition, McGraw.

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-422	FUNCTIONAL ANALYSIS-II	FUNCTIONAL ANALYSIS-I

SPECIFIC OBJECTIVES OF THE COURSE:

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

COURSE OUTLINE:

Inner product spaces, Hilbert spaces

Inner product space, Hilbert space, Further properties of Inner product spaces, Orthogonal complements and direct sums, Orthonormal sets and sequences, total orthonormal sets and sequences, representation of functional on Hilbert spaces, Hilbert adjoint operators, self adjoint, unitary and normal operators.

Fundamental Theorem for Normed and Banach spaces

Zorn's lemma, Hahn Banach theorem, Hahn Banach theorem for complex vector spaces and Normed spaces, Adjoint operator, reflexive spaces, Category theorem, Uniform bounded ness theorem, Open mapping theorem, Closed linear operators, Closed graph theorem.

Recommended Books

1. E. Taylor and D. C. Lay, Introduction to Functional Analysis, John Wiley & sons, 1980
2. G. F. Simmons, Introduction to topology and Modern Analysis, (Revised Edition) McGraw Hill Book Company.
3. R. F. Ourtain, A. J. Pritchard, Functional Analysis in Modern Applied Mathematics, Academic, Press, New York.
4. A. Friechmen, Foundations of Modern Analysis, 1982, Dover
5. E. Kreyszig, Introductory functional Analysis with applications, john Wiley and sons 1978.

Elective Courses

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-428	MATHEMATICAL MODELING	

Concepts of model, Methodology of mathematical modeling; objective, background, approximation and idealization, model validation compounding. Linear-differential equations, nonlinear differential equations and integral equations as models.

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: RC circuits, vibrations; modeling with periodic or impulse forcing functions. Modeling with systems of first order differential equations; application to biological systems; competitive hunter model; predator prey model. Partial-Differential Equations: Modeling wave phenomena (wave equation); uniform transmission line, traffic flow, modeling of electrical, mechanical, heat transferred and fluid systems.

Recommended Books

1. F.R. Giordano, M.D Weir, "Differential Equations: A Modeling Approach", Addison-Wesley, Reading, Ma, USA, 1994.
2. A.J Jerri, "Introduction to Integral Equations with Applications", Marcel Dekker, New York, 1985.
3. U.T. Myint , L. Debnath , "*Partial Differential Equations for Scientists and Engineers*" (3rd edition), North Holland, Amsterdam, 1987.
4. R.L.Woods & K.L. Lawrence, "*Modeling and Simulation of Dynamic Systems*", Prentice Hall USA, 1997

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-429	OPTIMIZATION THEORY-II	OPTIMIZATION THEORY-I

Theory of constrained optimization, condition of optimality, methods for minimizing a general function subject to linear equality constraints, active set strategies for linear inequality constraints, special forms of the objective functions, Lagrange multiplier estimates, changes in the working set, Barriers function methods, penalty functions methods, methods based on Lagrangian functions, reduced gradient and gradient projection methods

Recommended Books

1. M.S. Bazara, C.M. Shetty, Nonlinear Programming: Theory and Algorithms, John Willey, 1979.
2. M.A. Bhatti, Practical Optimization Methods with Mathematica Applications, Springer, 2000.
3. J.F. Bonnans, Numerical Optimisation: Theoretical and Practical Aspects, Springer, 2003.

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-427	FUZZY SET THEORY AND APPLICATIONS	

AIMS AND OBJECTIVES

The aim of the course is the introduction fuzzy set theory and their Mathematical properties. This is designed for graduate students and the graduate student will learn the basic properties of fuzzy set theory and they will able to apply fuzzy set theory to algebraic structures, Differential equations and partial differential equations

COURSE CONTENTS

Sets, Operation of Sets, Characteristics of Crisp Set. Brief History of Fuzzy set, Introduction of Fuzzy sets, Examples of fuzzy sets, Properties of Fuzzy sets. Applications of Fuzzy sets in other fields. Fuzzy Complement, Fuzzy Union, Fuzzy Intersection Other Operations in Fuzzy Set. Crisp Relation, Properties of Relation on a Single Set, Fuzzy Relation and Extension of Fuzzy Set, Properties of Fuzzy Relations, Properties of Fuzzy Relations, Review of ideals of semigroups, Definitions of Fuzzy Left, Fuzzy right and Fuzzy two-sided ideals of semigroups, Fuzzy generalized bi-ideals, Fuzzy bi-ideals, Fuzzy interior ideals and Fuzzy quasi-ideals

Recommended Books

1. Kwang H. Lee, (2005). First Course on Fuzzy Theory and Applications, Springer Berlin Heidelberg New York.
2. J. N. Mordeson, D. S. Malik, N. Kuroki. (2003). Fuzzy Semigroups, Springer-Verlag Berlin Heidelberg.
3. H.-J. Zimmermann, *Fuzzy Set Theory and its Applications*, 3rd edition, International Series in Management Science/Operation Research (Kluwer-Nijhoff Publishing, Dordrecht, 1988).
4. J.M. Howie, *An Introduction to Semigroup Theory*, Academic Press, London, 1976.

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-423	PARTIAL DIFFERENTIAL EQUATION	ODE

SPECIFIC OBJECTIVES OF COURSE:

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

COURSE OUTLINE:

First order PDEs: Introduction, formation of PDEs, solutions of PDEs of first order, The Cauchy's problem for quasi linear first order PDEs, First order nonlinear equations, Special types of first order equations

Second order PDEs: Basic concepts and definitions, Mathematical problems, Linear operators, Superposition, canonical form, Hyperbolic, Parabolic and Elliptic equations, PDEs of second order in two independent variables with constant and variable coefficients, Cauchy's problem for second order PDEs in two independent variables, Laplace equation, Wave equation, Heat equation

Methods of separation of variables: Solutions of elliptic, parabolic and hyperbolic PDEs in Cartesian and cylindrical coordinates

Fourier transforms: Fourier integral representation, Fourier sine and cosine representation, finite Fourier transforms, solutions of heat, wave and Laplace equations by Fourier transforms.

Recommended Books

- 1 Myint UT, *Partial Differential Equations for Scientists and Engineers*, 3rd edition, North Holland, Amsterdam, 1987.
- 2 Dennis G. Zill, Michael R. Cullen, *Differential equations with boundary value problems*, Brooks Cole, 2008.
- 3 John Polking, Al Boggess, *Differential Equations with Boundary Value Problems*, 2nd

Edition, Pearson, July 28, 2005.
 4 J. Wloka, Partial Differential Equations, Cambridge University press, 1987.

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-426	FLUID MECHANICS-II	FLUID MECHANICS-I
Constitutive equations; Navier-Stoke's equations; Exact solutions of Navier-Stoke's equations; Steady unidirectional low; Poiseuille flow; Couette flow; Unsteady unidirectional low; sudden motion of a plane boundary in a fluid at rest; Flow due to an oscillatory boundary; Equations of motion relative to a rotating system; Ekman flow; Dynamical similarity and the Reynold's number; Flow over a flat plate (Blasius' solution); Reynold's equations of turbulent motion		
Recommended Books		
<ol style="list-style-type: none"> 1. L.D. Landau and E.M. Lifshitz., Fluid Mechanics, Pergamon Press, 1966. 2. Batchelor, G.K., an Introduction to Fluid Dynamics, Cambridge University Press, 1969. 3. Walter Jaunzemis, Continuum Mechanics, MacMillan Company, 1967. 4. Milne-Thomson, Theoretical Hydrodynamics, MacMillan Company, 1967. 		

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-425	INTRODUCTION TO FIXED POINT THEORY	
Introduction to Fixed Point theory and its applications. Banach fixed point theorem. Contractive mapping. Kannan and Chatterjea, Zamfirescu fixed point theorems. Ciric's fixed point theorem. Weissinger, Rakotch, Boyd-Wong, Meir-Keeler, Hardy and Rogers and other generalization of contraction mapping. Common fixed point. Fixed point theorem for nonexpansive mappings and related classes of mappings. Quasi nonexpansive mappings. Fixed points of multivalued mappings and nonself mappings.		
Recommended Books		
<ol style="list-style-type: none"> 1. S. Almezal, Q. H. Ansari, M. A. Khamsi: Topics in Fixed Point Theory, Springer, 2014. 2. A. Granas, J. Dugundji: Fixed Point Theory, Springer, 2003. 3. R. P. Agarwal, M. Meehan, and D. O'Regan: Fixed point Theorey and Application, Cambridge University Press, 2004. 4. K. Goebel, W. A. Kirk: Topics in Metric Fixed Point Theory, Cambridge University Press, 1990. 5. W. A. Kirk, B. Sims: Handbook of Metric Fixed-Point Theory, Springer, 2001. 		

COURSE CODE	COURSE TITLE	PREREQUISITES
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MATH-414	VECTOR AND TENSOR	CALCULUS-II
SPECIFIC OBJECTIVES OF THE COURSE:		
This course shall assume background in calculus. It covers basic principles of vector analysis, which are used in mechanics		
COURSE OUTLINE:		
3_D vectors, Scalar-and vector products, triple products. Scalar and Vector-point functions, differentiation and integration of vectors, line integrals, path independence, surface integrals, volume integrals, gradient, divergence and curl with physical significance and applications, vector identities, Green's theorem in a plane, divergence theorem, Stokes' theorem, coordinate systems and their bases, the spherical-polar- and the cylindrical-coordinate. Summation convention, kronecker delta, Levi-Civita symbol.		
Vectors as quantities transforming under rotations with <i>ijk</i> notation. Alternating symbol, relation between alternating symbol and kronecker delta, tensors of first, second and higher orders, algebra of tensors, contraction of tensor, quotient theorem, quotient theorem, symmetric and skew-symmetric tensors, invariance property, isotropic tensors, differentiation of tensors, study of physical tensors (moment of inertia, index of refraction, etc.), diagonalization of inertia tensor as aligning coordinate frame with natural symmetries of the system. Vector fields. Line integrals. Green's theorem. Curl and divergence. Surface integrals over scalar and vector fields. Divergence theorem. Stokes' theorem.		
Recommended Books		
<ol style="list-style-type: none"> 1. D.E Bourne , P.C Kendall , “<i>Vector Analysis and Cartesian Tensors</i>” (2nd edition)Thomas Nelson 2001. 2. G.D Smith, “<i>Vector Analysis</i>”, Oxford University Press, Oxford 1999. 3. M.R Spiegel, “<i>Vector Analysis & Introduction to Tensor Analysis</i>”, McGraw Hill, New York 2009 		

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-415	FLUID MECHANICS-I	
Real fluids and ideal fluids, velocity of a fluid at a point, streamlines and path lines, steady and unsteady flows, velocity potential, vorticity vector, local and particle rates of change, equation of continuity. Acceleration of a fluid, conditions at a rigid boundary, general analysis of fluid motion.		
Euler's equations of motion, Bernoulli's equation steady motion under conservative body forces, some potential theorems, impulsive motion.		
Sources, sinks and doublets, images in rigid infinite plane and solid spheres, axi-symmetric flows, Stokes's stream function.		
Stream function, complex potential for two-dimensional, irrotational, incompressible flow, complex velocity potential for uniform stream. Line sources and line sinks, line doublets and line vortices, image systems, Miline-Thomson circle theroem, Blasius' theorem, the use of conformal transformation and the Schwarz-Christoffel transformation in solving problems, vortex rows.		
Kelvin' s minimum energy theorem, Uniqueness theorem, fluid streaming past a circular cylinder, irrotational motion produced by a vortex filament.		
The Helmholtz vorticity equation, Karman's vortex-street.		

Recommended Books
<ol style="list-style-type: none"> 1. Chorlton, F., Textbook of fluid Dynamics, D. Van Nostrand Co. Ltd. 1967. 2. Thomson, M., Theoretical Hydrodynamics, Macmillan Press, 1979. 3. Jaunzemics, W., Continuum Mechanic, Machmillan Company, 1967. 4. Landau, L.D., and Lifshitz, E.M., Fluid Mehanics, Pergamon Press, 1966. 5. Batchelor, G.K., An Introduction to Fluid Dynamics, Cambridge University Press, 1969.

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-424	PROBABILITY THEORY	INTRODUCTION TO STATISTIC
<p>SPECIFIC OBJECTIVE OF 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.</p> <p>COURSE OUTLINE: Introduction to probability theory; random variables; probability distributions; mean, standard deviation, variance and expectation. Binomial, negative binomial, Poisson,, geometric, hyper geometric and normal distributions; normal approximation to binomial distribution; distributions of 2 random variables.</p>		
<p>Recommended Books</p> <ol style="list-style-type: none"> 1. DeGroot MH, Schervish MJ, Probability and Statistics (3rd edition), 2002, Addison-Wesley, Reading, Ma, USA (suggested text) 2. Papoulis A, Probability, Random Variables, and Stochastic Processes,(3rd edition), 1991, McGraw Hill, New York 3. SM Chaudhry and Shahid Kamal (2012) introduction to statistical theory, latest edition, 		

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-416	MATHEMATICAL STATISTIC	PROBABILITY THEORY
<p>Continuous Probability Distributions: introduction, uniform distribution, exponential distribution, Gamma and Beta distribution, normal distribution, exercise*</p> <p>Simple Regression and Correlation: Introduction, simple linear Regression and Correlation, Rank Correlation, exercise*</p> <p>Chi-square distribution: properties of chi-square distribution, exercise*</p> <p>*related exercise</p>		
<p>Recommended Books</p> <ol style="list-style-type: none"> 1. SM Chaudhry and Shahid Kamal (2012) introduction to statistical theory, latest edition, Ilmi Kitab Khana. 		

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-416	FLUID MECHANICS-I	
<p>Real fluids and ideal fluids, velocity of a fluid at a point, streamlines and path lines, steady and unsteady flows, velocity potential, vorticity vector, local and particle rates of change, equation of continuity. Acceleration of a fluid, conditions at a rigid boundary, general analysis of fluid motion.</p> <p>Euler's equations of motion, Bernoulli's equation steady motion under conservative body forces, some potential theorems, impulsive motion.</p> <p>Sources, sinks and doublets, images in rigid infinite plane and solid spheres, axi-symmetric flows, Stokes's stream function.</p> <p>Stream function, complex potential for two-dimensional, irrotational, incompressible flow, complex velocity potential for uniform stream. Line sources and line sinks, line doublets and line vortices, image systems, Milne-Thomson circle theorem, Blasius' theorem, the use of conformal transformation and the Schwarz-Christoffel transformation in solving problems, vortex rows.</p> <p>Kelvin's minimum energy theorem, Uniqueness theorem, fluid streaming past a circular cylinder, irrotational motion produced by a vortex filament.</p> <p>The Helmholtz vorticity equation, Karman's vortex-street.</p>		
Recommended Books		
<ol style="list-style-type: none"> 6. Chorlton, F., Textbook of fluid Dynamics, D. Van Nostrand Co. Ltd. 1967. 7. Thomson, M., Theoretical Hydrodynamics, Macmillan Press, 1979. 8. Jaunzemics, W., Continuum Mechanic, Machmillan Company, 1967. 9. Landau, L.D., and Lifshitz, E.M., Fluid Mehanics, Pergamon Press, 1966. 10. Batchelor, G.K., An Introduction to Fluid Dynamics, Cambridge University Press, 1969. 		

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-417	MEASURE INTEGRATION	
<p>Lebesgue measure, Outer measure and measurability. Measurable set and Lebesgue measure, A non-measurable set, measurable function. The Lebesgue Integral of a bounded function. The general Lebesgue integral. Lebesgue integral and its relation to Riemann integral. Convergence in measure</p>		
Recommended Books		
<ol style="list-style-type: none"> 1 H.L.Royden, "<i>Real Analysis</i>", The McMillan Co., 1968. 2 D.Barra, "<i>Measure Theory & Integration</i>", Ellis Harwood Ltd., 1981. 3 P.R.Halmos, "<i>Measure Theory</i>", Von Nostrand N.Y. 1950. 		

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-418	DYNAMICS	
<p>Kinematics of particles and Rigid Bodies Velocity and acceleration of a particle along a curve, Motion in a plane-radial and transverse components, Relative velocity and acceleration, Vector angular velocity, general motion of a rigid body, Moving axes. Particle Dynamics Problems in two and three dimensions, projectile motion under gravity, shot putt analysis, projectile motion in resisting medium, Constrained particle motion, Simple pendulum, angular momentum of a particle with examples, Orbital Motion Motion of a particle under a central force, use of reciprocal polar co-ordinates with examples, Use of pedal coordinates and equations, Kepler's laws of planetary motion and Newton's law of Gravitation with example Introduction to rigid body dynamics Moments and products of inertia, the theorem of parallel and perpendicular axes, angular momentum of a rigid body about a fixed point and about fixed axes</p>		
Recommended Books		
<ol style="list-style-type: none"> 1. F.Charlton, "<i>Text book of Dynamics</i>", Ellis Harwood Ltd., 1983. 2. L.A.Pars, "<i>Introduction to Dynamics</i>", Cambridge Uni. Press, 1953. 3. A.S.Ramsey, "<i>Dynamics Part-I</i>", Cambridge Uni. Press, 1962. 4. J.L.Synge, and B.A.Griffith, "<i>Principle of Mechanics</i>", McGraw Hill, 1970 		

COURSE CODE	COURSE TITLE	PREREQUISITES
MATH-419	OPTIMIZATION THEORY-II	OPTIMIZATION THEORY-I
<p>Theory of constrained optimization, condition of optimality, methods for minimizing a general function subject to linear equality constraints, active set strategies for linear inequality constraints, special forms of the objective functions, Lagrange multiplier estimates, changes in the working set, Barriers function methods, penalty functions methods, methods based on Lagrangian functions, reduced gradient and gradient projection methods</p>		
Recommended Books		
<ol style="list-style-type: none"> 1. M.S. Bazara, C.M. Shetty, <i>Nonlinear Programming: Theory and Algorithms</i>, John Willey, 1979. 2. M.A. Bhatti, <i>Practical Optimization Methods with Mathematica Applications</i>, Springer, 2000. 3. J.F. Bonnans, <i>Numerical Optimisation: Theoretical and Practical Aspects</i>, Springer, 2003. 		

MATH-351 ADVANCED CALCULUS

Credit Hours: 3

Prerequisites: Calculus

Specific Objectives of course: This is second course of Calculus and builds up on the concepts learned in calculus. The students would be introduced to techniques and applications of integrals. The course also aims at introducing the students to Analytical Geometry and applications.

Course Outline:

Integration; Estimating with finite sums; sigma notation and limits of finite sums; the definite integral; the fundamental theorem of calculus; indefinite integrals and substitution rule; substitution and area between curves; Application of definite integrals; Volumes by slicing and rotation about an axis; Volume by cylindrical shells; Length of plane curves; Inverse function and their derivatives; Natural logarithms; the exponential functions; a^x and $\log_a x$; Inverse trigonometric functions; Hyperbolic functions; Basic Integration formulas; Integration by parts; Integration of rational functions by partial fractions; Trigonometric integrals; Trigonometric substitutions; Numerical integrals; Improper integrals; Slopes Fields and separable differential equations; First order differential equation;

Recommended Books;

1. Thomas, Calculus, 11th Edition. Addison Wesley Publishing Company, 2005
2. H.Anton, I. Bevens, S. Davis, Calculus, 8th Edition, John Wiley & Sons, In. 2005
3. Adler, Andrew, Coury, John E. The Theory of Numbers, Jones and Barttlet Publishers, Boston, 1995.
4. Burton, D.M. Elementary Number Theory McGraw Hill, 2000.

MATH-352 LOGIC & CRITICAL REASONING

Credit hours: 3

Contents:

Logic: logical statements and connectives; truth tables; tautology, absurdity and contingency; logical gates. Permutations, Mathematical induction, fundamental theorem of arithmetic, Compound and simple propositions, Truth tables, Permutations, Combinations.

Recommended Books:

1. S. Susanna: Discrete mathematics with applications, (2000).
2. K. H. Rosen: Discrete mathematics and its applications, (1999).
3. B. Kolman, R. C. Busby and S. Ross: Discrete mathematical structures, (1996).

MATH-451 RESEARCH METHODS

Matlab, Mathematica, Latex, Scientific Work Place

MATH-452 TOPOLOGY

Course Outline

Topological space, Open and closed sets, subspaces, Neighborhoods, limit points, closure of a set, Interior, exterior and boundary of a set, Base and sub base, Neighborhood bases, First and second axioms of countability, Definition and various examples of metric spaces, Open ball (or open sphere) and closed balls, Separable spaces, Continuous functions and homeomorphism, Separation axioms T1 and T2 spaces and their characterization, Regular spaces, connected spaces, disconnected spaces. Topology induced by a metric, Cauchy sequence, complete metric spaces.