DEPARTMENT OF MATHEMATICS
SCHOOL OF MATHEMATICAL SCIENCES
KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

'A' Grade
NAAC Re-Accredited (3rd Cycle)

SYLLABUS under CBCS for M. Sc. Mathematics (with specialization in Computational Mathematics)

WITH EFFECT FROM

ACADEMICYEAR 2019-2020

Summary of Distribution of Credits under CBCS Scheme for M.Sc. Mathematics (with Specialization in Computational Mathematics)

Sr. No	Course Type	Sem I	Sem II	Sem III	Sem IV
01	Core	16	16	08	08
02	Skill based	04	04	04	04
03	Core School Elective	-	-	08	08
04	Practical	03	03	03	03
05	Audit	02	02	02	02
	Total Credits	**25**	**25**	**25**	**25**

Subject Type	Core	Core School Elective	Skill Based	Practical	Audit	Total
Credits	48	16	16	12	08	100

Total Credits = 100

Course Credit Scheme

Semester	(A) Core Course			(B) Skill Based/Elective Course			(C) Audit course (No. Weightage in CGPA)			Total Credits (A+B+C)
	No.of Courses	Credits	Total Credits	No.of Courses	Credits (T+P)	Total Credits	No.of Courses	Credits (practical)	Total Credits	
I	5	4	20	1	0+3	3	1	2	2	25
II	5	4	20	1	0+3	3	1	2	2	25
III	3	4	12	3	8+3	11	1	2	2	25
IV	3	4	12	3	8+3	11	1	2	2	25
Total Credits	64			28			08			100

Structure of Curriculum

		First Year				Second Year				Total Credit Value
		Semester I		Semester II		Semester III		Semester IV		
		Credit	Course	Credit	Course	Credit	Course	Credit	Course	
(A)	**Prerequisite and Core Courses**									
	Theory	4	5	4	5	4	5	4	5	80
	Practical	0	0	0	0	0	0	0	0	00
(B)	**Skill Based / Subject Elective Courses**									
1	Theory /Practical	3	1	3	1	3	1	3	1	12
(C)	**Audit Course (No weightage in CGPA calculations)**									
1	Practicing Cleanliness	2	1							2
2	Soft Skills Practicing Sport activities Practicing Yoga Introduction to Indian Music			2	1					2
3	Computer Skills Cyber Security Introduction to Latex History of Mathematics					2	1			2
4	Human Rights Current Affairs Review of Research Papers Vedic Mathematics							2	1	2
	Total Credit Value	25	7	25	7	25	7	25	7	100

List of Audit Courses (Select any ONE course of Choice from Semester II; Semester III and Semester IV)							
Semester I (Compulsory)		**Semester II** (Choose One)		**Semester III** (Choose One)		**Semester IV**(Choose One)	
		Personality and Cultural Development		**Technology + Value Added Course**		**Professional and Social + Value Added Course**	
Course Code	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**
AC-101	Practicing Cleanliness	AC-201 (A)	Soft Skills	AC-301(A)	Computer Skills	AC-401(A)	Human Rights
		AC-201 (B)	PracticingSport Activities	AC-301(B)	Cyber Security	AC-401 (B)	Current Affairs
		AC-201 (C)	PracticingYoga	AC-301(C)	Introduction to Latex	AC-401(C)	Review of Research Papers
		AC-201 (D)	Music	AC-301(D)	History of Mathematics	AC-401(D)	Vedic Mathematics

DEPARTMENT OF MATHEMATICS, SCHOOL OF MATHEMATICAL SCIENCES
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Syllabus Structure M.Sc. Mathematics (with Specialization in Computational Mathematics) under CBCS

Semester-I

Course Code	Title of the Course	Contact hours/week			Distribution of Marks for Examination						Credits
					Internal		External		Total		
		Th	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
MT-101	Real Analysis	04	--	04	40	--	60	--	100	--	04
MT-102	Topology	04	--	04	40	--	60	--	100	--	04
MT-103	Linear Algebra	04	--	04	40	--	60	--	100	--	04
MT-104	Abstract Algebra	04	--	04	40	--	60	--	100	--	04
MT-105	Programming in C++	04	--	04	40	--	60	--	100	--	04
MT-106	Practical-I	--	06	06	--	40	--	60	--	100	03
AC-101	Practicing Cleanliness	02	--	02	100	--	--	--	100	--	02
Total Credit for Semester I: 25 (Core: 16; skill based :04; P = Practical: 03 Audit Course:02)											

Semester-II

Course Code	Title of the Course	Contact hours / week			Distribution of Marks for Examination						Credits
					Internal		External		Total		
		Th	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
MT-201	Complex Analysis	04	--	04	40	--	60	--	100	--	04
MT-202	Measure and Integration Theory	04	--	04	40	--	60	--	100	--	04
MT-203	Ordinary Differential Equations	04	--	04	40	--	60	--	100	--	04
MT-204	Advanced Abstract Algebra	04	--	04	40	--	60	--	100	--	04
MT-205	Numerical Analysis	04		04	40		60	--	100	--	04
MT-206	Practical-II	--	06	06	--	40	--	60	--	100	03
AC-201(A)	Soft Skills	02	--	02	100	--	--	--	100		02
AC-201(B)	Practicing Sport activities										
AC-201(C)	Practicing Yoga										
AC-201(D)	Introduction to Indian Music										
Total Credit for Semester II: 25 (Core: 16; skill based :04; P = Practical: 03 Audit Course:02)											

- Syllabus for AC-101 and AC-201A/B/C/D will be available on university website separately.
- Choose any one from AC-201(A), AC-201(B), AC-201(C) and AC-201(D)

Semester-III

Course Code	Title of the Course	Contact hours / week			Distribution of Marks for Examination						Credits
					Internal		External		Total		
		Th	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
MT-301	Functional Analysis	04	--	04	40	--	60	--	100	--	04
MT-302	Partial Differential Equations	04	--	04	40	--	60	--	100	--	04
MT-303	Choose One from MT-303(A), 303(B), 303(C), 303(D), 303(E)	04	--	04	40	--	60	--	100	--	04
MT-304	Choose One from MT-304(A), 304(B), 304(C), 304(D), 304(E)	04	--	04	40	--	60	--	100	--	04
MT-305	Programming in MATLAB	04	--	04	40	--	60	--	--	100	04
MT-306	Practicals-III	--	06	--	--	40	--	60	--	100	03
AC-301(A)	Computer Skills	02	--	02	100	--	--	--	100	--	02
AC-301(B)	Cyber Security										
AC-301(C)	Introduction to Latex										
AC-301(D)	History of Mathematics										
Total Credit for Semester III: 25 (Core: 08; skill bases-04;Program Elective: 08; P = Practical: 03 Audit Course:02)											

- **List of elective courses to be offered in Semester-III for MT 303:**
  MT-303(A): Classical Mechanics MT-303(B): Algebraic Coding Theory
  MT-303(C): Special Functions MT-303(D): Advanced Calculus
  MT-303(E): Differential Geometry
- **List of elective courses to be offered in Semester-III for MT 304:**
  MT-304(A): Graph Theory MT-304(B): Stability Theory MT-304(C): Probability TheoryMT-304(D): Lattice Theory MT-304(E): Algebraic Topology
- Syllabus forAC-301(A) and AC-301(B)will be available on university website separately.
- Choose any one from AC-301(A), AC-301(B), AC-301(C) and AC-301(D)

Semester-IV

Course Code	Title of the Course	Contact hours / week			Distribution of Marks for Examination						Credits
					Internal				Total		
		Th	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
MT-401	Analytic Number Theory	04	--	04	40	--	60	--	100	--	04
MT-402	Transform Theory	04	--	04	40	--	60	--	100	--	04
MT-403	Choose One from MT-403(A), 403(B), 403(C), 403(D), 403(E)	04	--	04	40	--	60	--	100	--	04
MT-404	Choose One from MT-404(A), 404(B), 404(C), 404(D), 404(E)	04	--	04	40	--	60	--	100	--	04
MT-405	Operations Research	04		04	40	--	60	--	100	--	04
MT-406	Practicals-IV	--	06	--	--	40	--	60	--	100	03
AC-401(A)	Human Rights	02	--	02	100	--	--	--	100	--	02
AC-401(B)	Current Affairs										
AC-401(C)	Review of Research Papers										
AC-401(D)	Vedic Mathematics										
Total Credit for Semester III: 25 (Core: 08; skill bases-04;Program Elective: 08; P = Practical: 03 Audit Course:02)											

- **List of elective courses to be offered in Semester-IV for MT 403:**

MT-403(A): Advanced Functional Analysis
MT-403(B): Linear Integral Equations
MT-403(C): Difference Equations
MT-403(D): Cryptography
MT-403(E): Fractional Calculus

- **List of elective courses to be offered in Semester-IV for MT 404:**

MT-404(A): Fuzzy Sets and Applications
MT-404(B): Commutative Algebra
MT-404(C): Wavelet Analysis
MT-404(D): Control Theory
MT-404(E): Fixed Point Theory and Applications

- Syllabus forAC-401(A) and AC-401(B) will be available on university website separately.
- Choose any one from AC-401(A), AC-401(B), AC-401(C) and AC-401(D)

Program at a Glance

M.Sc. Mathematics (with Specialization in Computational Mathematics)

Name of the program	: M. Sc. (Mathematics)
Faculty	: Science and Technology
Duration of the Program	: Two years (four semesters)
Medium of Instruction and Examination	: English
Examination Pattern	: 60: 40 (60 marks University exam and 40 marks Departmental internalexam. Continuousassessment)
Passing standards	:40% in each exam separately (separate head of passing)
Evaluation mode	: CGPA
Total Credits of the program	: 100 (48 core credits, 16 skill based credits, 16 subject elective credits, practical 12 creditand 08 audit credits)

Program Objectives for M.Sc. Program:

1. To impart the profound theoretical and practical knowledge of the specific science discipline along with the fundamental core concepts
2. To train the students to employ modern techniques, tools, methodologies, equipment, hardware/software etc to perform objective oriented scientific and planned experiments
3. To groom the students for all-round development and mould them in a trained workforce to provide teaching-learning, research, business, professional supports in the various science disciplines
4. To make the student to develop the ability to think analytically, independently and draw logical conclusions to solve real-life problems.
5. To utilize the skills and knowledge gained through the subject to deal with real life situations and problems related to society, environment, research and development etc.

Program Outcomes (PO):

Upon successful completion of the M.Sc. program, student will be able to:

PO No.	Program Outcome	Cognitive level
PO1	To understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevancies in the day-to-day life.	2
PO2	Administer the skills in handling scientific instruments, planning and performing in laboratory experiments.	3
PO3	Analyze the given scientific experimental data critically and systematically and the ability to draw the objective conclusions.	4
PO4	Develop various skills such as communication, managerial, leadership, entrepreneurship, teamwork, social, research etc., which will help in expressing ideas and views clearly and effectively.	3
PO5	Model and formulate the real problems and find solution based-on knowledge acquired.	6
PO6	To evaluate how developments in any science subject helps in the development of other science subjects and vice-versa and how interdisciplinary approach helps in providing better solutions and new ideas for the sustainable developments.	5

Program Specific Objectives (PSO's):

Through this degree program

1. Students will be able to innovate, invent and solve complex mathematical problems using the acquired knowledge of pure and applied mathematics.
2. Students will be able to acquire advanced mathematical, computational and skills based knowledge required for professional activities.
3. Students will be able to pursue higher studies and inter-disciplinary research.
4. Students will be able to tackle problems faced by the society and industry through mathematical modeling.

Program Specific Outcomes:

After completion of the M. Sc. Mathematics program, the students should be able:

Program Specific Outcome (PSO) No.	Program Specific Outcome	Cognitive Level
PSO1	To understand the basic concepts, fundamental principles, and the scientific theories related to mathematics.	2
PSO2	To develop logical and analytical thinking to apply the skills in handling scientific calculations, planning and performing laboratory practicals.	3
PSO3	To grasp and analyze the notions and theorems in mathematics to draw or predict logical conclusions.	4
PS04	To develop various skills such as logical thinking, derivations, technical calculations, research ability etc., this will help in expressing ideas and views clearly and effectively.	4
PS05	To model and formulate the physical problems to find solution based-on knowledge acquired.	6

Subject-wise course objectives and outcomes

MT-101: - REAL ANALYSIS

Course Objectives:

The objectives of this course are

1) Learn some of the properties of Riemann-Stieltjesintegrable functions, and the applications of the fundamental theorems of integration.
2) to study of sequences and series of functions, series and Stone-Weierstrass theorem
3) to understand the concept of functions of several variables and its applications

Unit I: The Riemann-Stieltjes Integral

Definition and Existence of the integral, Properties of integral, Integration and differentiation, Integration of vector-valued functions, Rectifiable curves.

{Chapter 6 [1]}[10Lectures]

Unit II: Sequences and Series of functions

Rearrangement of series, Pointwise and uniform convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, Dirichlets test for uniform convergence, The Stone-Weierstrasstheorem.**{Chapter 3[1] (3.52 to 3.55), Chapter 7[1] & Chapter 9[2] (9.11)}**[**20 Lectures**]

Unit III: Power Series

Uniqueness theorem for power series, Abel's limit theorem, Taubers first theorem.**{Chapter 8[1] (8.1 to 8.4) & Chapter 9[2] (9.23)} [10 Lectures]**

Unit IV: Functions of Several Variables

Linear transformations, Differentiation, The contraction principle, The inverse function theorem, The implicit function theorem. **{Chapter 9[1] }[20 Lectures]**

Recommended Text Books:

[1] Walter Rudin: Principles of Mathematical Analysis, McGraw-Hill Book Company, 3rd Edition (2013).

[2] T. M. Apostol: Mathematical Analysis, Narosa Publishing House, 2nd Edition (1977).

Reference Books:

[1] D. Somasundaram, A Second Course in Mathematical Analysis, Alpha Science International Ltd. (2009)

[2] S. C. Malik and Savita Arora, Mathematical Analysis, New Age International Publishers, 4th Edition (2010).

Course Outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT101.1	Discuss various tests to check pointwise	2
MT101.2	Construct rigorous mathematical proofs of results such as Stone-Weierstrass theorem. uniqueness theorem for power series	3
MT101.3	Apply the theory of function of several variables to solve mathematical problems including the construction of simple proofs for the contraction principle	3
MT101.4	Analyze the properties of integral	4

MT- 102:TOPOLOGY

Course objectives:

The objectives of this course are

1) To understand standard concepts of Set theory, analyze structure of open sets, closed sets, basis etc and other topological structures.
2) To understand definitions, construct examples and counter examples based on definitions.
3) To develop intuition regarding proofs, make arguments based on logic.
4) To study the topological and hereditary properties of topological spaces.

Unit I. Topological spaces:

Countable and uncountable sets, Topological Spaces, Basis for a Topology, The Order Topology, The Product Topology on $X \times Y$, The Subspace Topology, Closed Sets and Limit Points. **{Chapter 1 [1] (Art. 7), Chapter 2 [1] (Art. 12-17)} [15 Lectures]**

Unit II: Continuous Functions:

Continuous Functions, The Product Topology, The Metric Topology, The Quotient Topology. **{Chapter 2 [1] (Art. 18, 19, 22)}[10 Lectures]**

Unit III: Connectedness:

Connected Spaces, Components and Local Connectedness **{Chapter 3 [1] (Art. 23, 25)} [10 Lectures]**

Unit IV: Compactness:

Compact Spaces, Compact Subspaces of the Real Line, Limit Point Compactness, Local Compactness{ **Chapter 3 [1] (Art. 26-29)} [10 Lectures]**

Unit V. Countability and Separation Axioms

The Countability Axioms, The Separation Axioms, Normal Spaces, The Urysohn Lemma, The UrysohnMetrization Theorem, The Tietze Extension Theorem.

{**Chapter 4 [1] (Art. 30-35)} [15 Lectures]**

Recommended Textbooks:

[1] J. R. Munkres, Topology, 2nd edition, Prentice Hall of India (2000).

Reference Books:

[1] G. F. Simmons, Introduction to topology & Modern Analysis, McGraw Hill Education, 1st Edition (2004)
[2] W. J. Perwin, Foundation of General topology, Academic Press (1964).
[3] K. D. Joshi, Introduction to general topology, Wiley Eastern Limited (1984).

Course outcomes:

Upon successful completion of this course students will

Course Outcome	Course Outcome	Cognitive Level
MT102.1	Classify the concept of open and closed sets, interior, closure and boundary points.	2
MT102.2	Focus on new topological spaces by using subspace, product and quotient topologies. Use continuous functions and homeomorphisms to understand structure of topological spaces.	4
MT102.3	Apply theoretical concepts in topology to understand real world applications.	3

MT-103: LINEAR ALGEBRA

Course objectives:

The objectives of this course are

1) to comprehend generalized notion of vectors and their properties, dual spaces, inner product spaces and modules.
2) to understand properties of linear transformations, characteristic roots, matrix corresponding to linear transformation and their canonical forms.
3) to depict properties of determinants, linear operators and quadratic forms.

Unit I: Vector Spaces and Modules

Elementary Basic Concepts, Linear Independence and Bases, Dual Spaces, Inner Product Spaces, Modules. {**Chapter 4 [1] (Art. 4.1-4.5)**} [**20Lectures**]

Unit II: Linear Transformations

The algebra of linear transformations, Characteristics roots, Matrices, Canonical Forms. {**Chapter 6 [1] (Art. 6.1-6.7)**} [**25 Lectures**]

Unit III: Determinants and Types of Linear Transformations

Trace and Transpose, determinants, Hermitian, Unitary and Normal Transformations, Real Quadratic Forms. {**Chapter 6[1] (Art. 6.8-6.11)**}[**15 Lectures**]

Recommended Text Books:

[1]. I. N. Herstein, Topics in Algebra, 2nd Edition, Wiley Eastern Ltd, New Delhi, (1975).

Reference Books:

[1]. Hoffman, Kenneth and Kunze R, Linear Algebra, Prentice Hill of India Private Limited. (1984).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT103.1	Visualize the linear operators namely adjoint, self-adjoint and normal operators	1
MT103.2	Express that the set of linear transformations forms a linear space, this is isomorphic to subalgebra of some vector space.	2
MT103.3	Predict that every linearly independence set can induce an orthonormal basis.	3
MT103.4	Establish that if a linear transformation has as all characteristic roots in a field, then matrix of it some basis is diagonal and has special forms known as canonical forms.	3

MT-104: ABSTRACT ALGEBRA

Course objectives:

The objectives of this course are

1) to understand basic concepts of direct product groups, Sylow's theorems, Jordan- Holder theorem and solvable groups
2) to demonstrate Euclidean domains, principal ideal domains and unique factorization domains.
3) to discuss polynomial rings their roots and factorizations.

Unit I: Groups:

(Prerequisites: Groups and Subgroups, Homomorphisms and Cosets). Direct Products of groups: Internal and External, Conjugate Classes, Class Equation, Sylow's theorems its applications, p-Sylow subgroups.

{Chapter 1 [1](Article 1.10-1.12)}[20 Lectures]

Unit II: Solvable groups:

Normal series and subnormal series, Butterfly lemma, Jordan Holder theorem, Solvable groups. **{Chapter 1 [1](Article 1.13-1.14)}[10 Lectures]**

Unit II: Rings:

(Prerequisites: Rings and subrings, Examples of rings, types of rings and characteristic of a ring). Euclidean domain, Principal Ideal Domain,

{Chapter 2 [1] (Article 2.10-13} [15 Lectures]

Unit IV: Factorization of rings

Unique Factorization Domain Polynomial rings, Roots of Polynomials, Factorization of Polynomials, Gauss lemma.

{Chapter 2 [1] (Article 2.14-16} [15 Lectures]

Recommended Text Books:

[1]. N. S. Gopalakrishnan, University Algebra, Wiley Eastern Ltd (1988).

Reference Books:

[1]. I. N. Herstein, Topics in Algebra, 2nd Edition, Wiley Eastern Ltd, New Delhi, (1975).

[2]. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul: Basic Abstract Algebra, 2nd edition, Cambridge University press, Indian Edition, (1997).

[3]. Dummit and Foote, Abstract Algebra,3rd Edition, Wiley - Eastern Ltd. (2014).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT104.1	Explain that the internal and external direct products of groups are isomorphic.	3
MT104.2	Predict that converse of Lagrange's theorem is true for prime divisors and highest prime power divisors.	3
MT104.3	Established that any two-composition series of a finite group are isomorphic.	3
MT104.4	See that in case of ED, PID and UFD's any two elements have a greatest common divisor.	1
MT104.5	Describe that product of primitive polynomials is again a primitive polynomial and ring of polynomials over a UFD is again a UFD.	2

MT-105: PROGRAMMING IN C++

Course objectives:

The objectives of this course are

1) To understand how C++ improves C with object-oriented features.
2) To learn how to write inline functions for efficiency and performance.
3) To learn how to design C++ classes for code reuse and to learn how to overload functions and operators in C++.

Unit I: Beginning with C++

{Chapter 2 [1] (Article 2.1-2.8)} [08 Lectures]

Unit II: **C++ Tokens, Expressions and Control Structure.**
{Chapter 3 [1] (Article 3.1-3.25)} [10 Lectures]

Unit III: **Functions in C++**
{Chapter 4 [1] (Article 4.1-4.12)} [08 Lectures]

Unit IV: **Classes and Objects**
{Chapter 5 [1] (Article 5.1-5.19)} [08 Lectures]

Unit V: **Constructors and Destructors**
{Chapter 6 [1] (Article 6.1-6.11)} [06 Lectures]

Unit VI: **Operator Overloading and Type Conversions**
{Chapter 7 [1] (Article 7.1-7.9)} [08 Lectures]

Unit VII: **Inheritance: Extending Classes**
{Chapter 8 [1] (Article 8.1-8.12)} [06 Lectures]

Unit VIII: **Pointers, Virtual Functions and Polymorphism**
{Chapter 9 [1] (Article 9.1-9.8)} [06 Lectures]

Recommended Text Books:

[1]. E. Balaguruswamy, Object-Oriented Programming with C++, 5th Edition, Tata McGraw Hill, New Delhi (2012).

Reference Books:

[1]. John R. Hubbard, Schaum's Outline of Fundamentals of Computing with C++, Schaum's Outline Series, (2000).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT105.1	Visualize the features of C++ supporting object-oriented programming.	1
MT105.2	Construct how to produce object-oriented software using C++	3
MT105.3	Survey the major object-oriented concepts to implement object-oriented programs in C++, encapsulation, inheritance and polymorphism.	4

MT-106: PRACTICAL-I

Course objectives:

The objectives of this course are

1) To write, understand and practice the simple C++ program codes.
2) To write, understand and practice the C++ program codes based on functions, function and operator overloading.
3) To write, understand and practice the C++ program codes based on arrays, pointers and classes.

List of C++ Programs to be coved under this practical course

1. C++ Program to find perfect number.
2. C++ Program to find prime number in C++.
3. C++ Program to convert the given temperature from Fahrenheit to degree Celsius.
4. C++ Program to find greatest number between 3 number using if-else-if statements.
5. Define functions for following:
   - **i.** To find factorial of number.
   - **ii.** To find table of a given number using for loop.
   - **iii.** To find the area and perimeter of rectangle.
   - **iv.** To find the area of triangle.
   - **v.** To calculate area of circle.
   - **vi.** To swap the values of two integers.
   - **vii.** To swap two variables without using third variable or temporary variable.
   - **viii.** To find maximum and minimum number.
   - **ix.** To find the last prime number before number entered.
   - **x.** To find Fibonacci series with simple logic.
   - **xi.** To check given number is Palindrome Number or not.
   - **xii.** To check given number is Armstrong Number or not.
   - **xiii.** To print a right-angle triangle using for loop.
   - **xiv.** To find GCD of two numbers.
   - **xv.** Switch statements in C++ to calculate grade points when user enter a grade.
6. C++ program to check entered character is small, capital, digit or a special character.
7. C++ Program to find the Largest and Smallest number in given array.
8. C++ program take hours, minutes, seconds and print it in 24 hours & 12 hours format using class.
9. C++ code for operations of matrices using 'matrix' class.
   Addition, Subtraction, Multiplication and transpose.
10. C++ code for operationsofComplex numbers using 'complex' class.
    Addition, Subtraction, Multiplication, Conjugate, modulus etc.

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT106.1	Understand use of control and conditional statements by using simple test C++ program codes.	4
MT106.2	Correlate the concept of function and operator overloading using C++ program codes.	4
MT106.3	Writes C++ programs for use of arrays, pointers and classes.	6

AC-101: PRACTICING CLEANLINESS

Course objectives:

1) To make students aware of Clean India Mission and inculcate cleanliness practices among them.

- Awareness program on
    - Swachh Bharat Abhiyan (Clean India Mission)
    - Clean Campus Mission
    - Role of youth in Clean India Mission
- Cleaning activities inside and surroundings of Department buildings.
- Tree plantation and further care of planted trees
- Waste(Liquid/Solid/e-waste) Management, Japanese 5-S practices
- Planning and execution of collection of Garbage from different sections of University campus
- Role of youth in power saving, pollution control, control of global warming, preservation of ground water and many more issues of national importance.
- Cleanest School/Department and Cleanest Hostel contests
- Painting and Essay writing competitions

Course outcomes:

Course Outcome	Course Outcome	Cognitive Level
AC101.1	Identify need at of cleanliness at home/office and other public places	1
AC101.2	Plan and observe cleanliness programs at home and other places	4
AC101.3	Practice Japanese 5-S practices in regular life	3

MT-201: COMPLEX ANALYSIS

Course objectives:

The objectives of this course are

1) To identify and construct complex-differentiable functions, the concepts of analytic functions, harmonic function and the importance of the Cauchy Riemann equations. To explain and apply Cauchy's integral formula and some of its consequences.
2) To learn the convergence of power series and develop analytical capabilities in Taylor or Laurent series in a given domain.
3) Students will describe the basic properties of singularities and zeros of analytic functions and calculate residues and use these to calculate integrals, account for conformal mappings and its connection with analytic functions.

Unit I: Elementary Properties and Examples of Analytic Functions

Power series, Analytic functions, Analytic functions as mappings, Mobius transformations **{Chapter 3 [1], (Art 1-3)}** **[15 Lectures]**

Unit II: Complex Integration

Riemann-Stieltjes integrals, Power series representation of analytic functions, Zeros of an analytic function, The index of a closed curve, Cauchy's Theorem and Integral

Formula, Counting zeros; the Open Mapping Theorem, Goursat's Theorem.
{Chapter 4 [1], (Art 1-5, 7-8)} **[25 Lectures]**

Unit-III Singularities

Classification of singularities, Laurent Series Development, Residues, The Argument Principle. **{Chapter 5 [1], (Art 1-3)}** **[15 Lectures]**

Unit-IV: The Maximum Modulus Theorem

The Maximum Principle, Schwarz's Lemma. **{Chapter 6 [1], (Art 1-2)}**

[05 Lectures]

Recommended Text Books:

[1]. J. B. Conwey, Functions of One Complex Variables, 2nd Edition, Springer Verlag, (2002).

Reference Books:

[1]. T. W. Gamelin, Complex Analysis, Springer-Verlag (2006).
[2]. James Ward Brown and Ruel V. Churchill, Complex Variablesand Applications, 8thEdition, McGraw-Hill, Companies, Inc., (2009).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT201.1	Determine whether a given function is differentiable, and if so find its derivative. Use power series and line integrals to construct differentiable functions. Construct branches of inverse functions.	3
MT201.2	Deduce whether given functions have antiderivatives, logarithms, and nth roots. use antiderivatives or Cauchy's integral theorem or formula to compute line integrals.	4
MT201.3	Find Laurent series about isolated singularities and determine residues. Use the residue theorem to compute several kinds of real integrals.	3
MT201.4	Construct conformal mappings between many kinds of domain.	3

MT-202: MEASURE AND INTEGRATION THEORY

Course objectives:

The objectives of this course are

1) Students will learn the fundamentals of measure, measurable set, outer measure, Borel set, measurable function etcand to be acquainted with the proofs of the fundamental theorems underlying the theory of integration.
2) Students will explain the concept of length, area, volume using Lebesgue theory. Apply the properties of integrals to the proof of completeness of certain functional spaces.

3) To introduce the general principles of measure theory and integration in such concrete subjects as the Theory of Probability or Financial Mathematics.

Unit I: Lebesgue Measure

Algebra of Sets, Lebesgue Outer Measure, Theσ-Algebra of Lebesgue Measurable Sets, Outer and Inner Approximation of Lebesgue Measurable Sets, Countable Additivity, Continuity and the Borel-Cantelli Lemma, Non-measurable Sets, The Cantor Set and the Cantor-Lebesgue Function. **{Chapter 2 [1], (Art. 2.1-2.7)} [15 Lectures]**

Unit-II: Lebesgue Measurable Functions

Sums, Products, and Compositions, Sequential Pointwise Limits and Simple Approximation, Littlewood's Three Principles, Egoroff's Theorem, and Lusin's Theorem **{Chapter 3 [1], (Art. 3.1-3.3)}[10 Lectures]**

Unit-III: Lebesgue Integration

The Riemann Integral, The Lebesgue Integral of a Bounded Measurable Function over a Set of Finite Measure, The Lebesgue Integral of a Measurable Nonnegative Function, The General Lebesgue Integral, Countable Additivity and Continuity of Integration, Uniform Integrability: The Vitali Convergence Theorem. **{Chapter 4 [1], (Art. 4.1-4.6)} [15 Lectures]**

Unit-IV: Differentiation and Integration

Continuity of Monotone Functions, Differentiability of Monotone Functions: Lebesgue's Theorem,Functions of Bounded Variation: Jordan's Theorem, Absolutely Continuous Functions, Integrating Derivatives: Differentiating Indefinite Integrals, Convex Functions. **{Chapter 6 [1], (Art. 6.1-6.6)} [10 Lectures]**

Unit-V: The L^P Spaces

Completeness and Approximation, Normed Linear Spaces, The Inequalities of Young, Holder, and Minkowski, L^P is Complete: The Riesz-Fischer Theorem. **{Chapter 7 [1], (Art. 7.1-7.3)} [10 Lectures]**

Recommended Text Books:

[1]. Royden H. L. and Fitzpatrick P. M, Real Analysis, 4th Edition, PHI Learning (2010).

Reference Books:

[1]. P. K. Jain and V. P. Gupta: Lebesgue Measure and Integration, 3rd Edition, New Age International (P) Ltd., New Delhi, 1986.
[2]. Inder K. Rana, An introduction to Measure & Integration, Narosa Pub. House, Delhi, (1997).
[3]. G. de. Barra, Measure Theory and Integration, Wiley Eastern Limited, (1981).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT202.1	Reproduce the basic concepts of measure theory and the theory of Lebesgue integration. Also, the student will understand the main proof techniques in the field, and he will also be able to apply the theory abstractly and concretely.	1
MT202.2	Write elementary proofs himself as well as more advanced proofs under guidance.	3
MT202.3	Correlate measure theory and integration in Riemann integration and calculus.	4
MT202.4	Correlate the concept of Lebesgue measure to exploit its special properties	4

MT-203: ORDINARY DIFFERENTIAL EQUATIONS

Course objectives:

The objectives of this course are

1) Explain the concepts of linear systems, ODE solution methods, and related ideas at a fundamental level, as well as how and why we use the solution techniques that we use.
2) Understand the existence and uniqueness theorem and its consequences for real as well as vector differential equations.
3) To provide a brief introduction to boundary value problems, Sturm-Liouville problems, oscillations of second order equations and stability of linear and nonlinear systems.

Unit I: System of Linear Differential Equations:

Systems of first order equations, Model for arms competition between two nations, Existence and uniqueness theorem, Fundamental matrix, Non-homogeneous linear systems, Linear systems with constant coefficients, Linear systems with periodic coefficients. **{Chapter 4 [1], (Art. 4.1-4.8)}** [**15 Lectures**]

Unit II: Existence and Uniqueness of Solutions:

Successive approximations, Picard's theorem, Continuation and dependence on initial conditions, Existence of solutions in the large, Existence and uniqueness of solutions of systems, Fixed point method. **{Chapter 5 [1], (Art. 5.1-5.9)}** [**15 Lectures**]

Unit III: Boundary Value Problems:

Sturm-Liouville problem, Green's function, Application of boundary value problems (BVP), Picard's theorem.**{Chapter 7 [1], (Art. 7.-7.5)}** [**10 Lectures**]

Unit IV: Oscillations of Second Order Equations:

Fundamental results, Sturm's comparison theorem, Elementary linear oscillations, Comparison theorem of Hille-Winter, Oscillations of $x''+a(t)x=0.$

{Chapter 8 [1], (Art. 8.1-8.5)} [**10 Lectures**]

Unit V: Stability of Linear and Nonlinear Systems:

Elementary critical points, System of equations with constant coefficients, Linear equation with constant coefficients.**{Chapter 9 [1], (Art. 9.1-9.4)}** [**10 Lectures**]

Recommended Text Books:

[1]. S. G. Deo, V. Lakshmikantham and V. Raghavendra, Text Book of Ordinary Differential Equations, Tata Mc-Graw Hill Publishing Company Limited, New Delhi (1997).

Reference Books:

[1]. Earl A. Coddington and Norman Levinson, Theory of Ordinary Differential Equations, McGraw Hill,New York (1972).
[2]. G. F. Simmons, Differential Equations with Applications and Historical Notes, 2nd Ed., McGraw- Hill, 1991.
[3]. Shepley L. Ross, Differential Equations, 3rd Edition, John Wiley and Sons Inc., (2004).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT203.1	Convert arbitrary higher-order linear equations to first order linear systems and use the eigenvalue/eigenvector method to solve systems linear, homogeneous ODEs with constant coefficients where the coefficient matrix is real-valued.	2
MT203.2	Discuss existence, uniqueness and other properties of a solution of differential equations	2
MT203.3	Demonstrate the ability to tackle problems on oscillations of second order equations and stability of linear and nonlinear systems.	4

MT-204: ADVANCED ABSTRACT ALGEBRA

Course objectives:

The objectives of this course are

1) to make students able to understand concepts in field theory such as finite and algebraic extensions, algebraic elements, constructible elements, solvable groups etc
2) to aware students the motive behind Galois theory and solvability by radicals
3) to understand applications of field theory for solving polynomial equations, systems of equations, ancient problems on impossibility of constructions and finding formula for solutions of polynomial equations.
4) to elaborate notions in finite field theory and their applications.

Unit I: Field Extensions

Extension Fields, The Transcendence of *e*, Roots of polynomials, Construction with Straight Edge and Compass, More about roots. {**Chapter 5 [1], Art.1-5)}**

[**20 Lectures]**

Unit II: Galois Theory

Elements of Galois Theory, Solvability by Radicals, Finite Fields. {**Chapter 5 [1], Art.6-7) and Chapter 7 [1], Art. 1}** [**20 Lectures]**

Unit III: Structure of Finite Fields

Characterization of finite fields, Roots of irreducible polynomials, Traces, Norms and Bases, Roots of unity and cyclotomic polynomials, Representation of elements of finite fields. {**Chapter 2 [2], Art.1-5)}** [**20 Lectures]**

Recommended Text Books:

[1]. I. N. Herstein, Topics in Algebra, 2nd Edition, Wiley Eastern Ltd, New Delhi, (1975).
[2]. Rudolf Lidl and Harald Niederreiter: Introduction to Finite Fields and their Applications, Cambridge University Press, Cambridge (1986).

Reference Books:

[1]. N. S. Gopalakrishnan, University Algebra, Wiley Eastern Ltd (1988).
[2]. John B. Fraleigh, A First Course in Abstract Algebra, 3rd Edition, Narosa Publishing House, New Delhi (1998).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT204.1	Establish that finite (algebraic) extension of finite (algebraic) extension is a finite (algebraic) extension	3
MT204.2	Explain the concepts such as fundamental theorem of algebra; the solvable groups and impossibilities to trisect an angle as well as squaring a circle	2
MT204.3	Justify the general polynomials over a field cannot be solved by radicals by using fundamental theorem of Galois theory.	5

MT-205: NUMERICAL ANALYSIS

Course objectives:

The objectives of this course are

1) To teach the student various topics in Numerical Analysis such as solutions of transcendental equation in one variable and direct methods for solving linear systems.
2) To understand and study the numerical methods related to interpolation and approximation.
3) To study numerical methods to find the numerical solution of ordinary differential equations and numerical integration.

Unit I: Solution of Algebraic and Transcendental Equations

Bisection Method, Iteration Method, Method of False Position, Newton-Raphson Method, Ramanujan's Method, Muller's Method. {**Chapter 2 [1], Art. 2.1-2.7**},

[12 Lectures]

Unit II: Interpolation

Errors in Polynomial Interpolation, Finite Differences, Detection of Errors by use of Difference Tables, Differences of a Polynomial, Newton's formulae for Interpolation, Central Difference, Interpolation with unevenly spaced points, Divided differences. {**Chapter 3 [1], (Art. 3.1-3.7, 3.9, 3.11)**}, **[12 Lectures]**

Unit III: Numerical Differentiation and Integration

Numerical Differentiation, Maximum and Minimum values of a Tabulated Function, Numerical Integration. {**Chapter 5 [1], (Art. 5.1-5.4)**}, **[12 Lectures]**

Unit IV: Matrices and Linear systems of Equations

Basic Definitions, Solution of Linear Systems-Direct Methods, Solution of Linear Systems-Iterative Methods, Eigenvalue Problem.

{**Chapter 6 [1], (Art. 6.1-6.5)**}, **[12 Lectures]**

Unit V: Numerical Solutions of Ordinary Differential Equations

Solution by Taylor's Series, Picard's Method of Successive approximations, Euler's Method, Runge-Kutta methods, Predictor Corrector methods.

{**Chapter 7 [1], (Art. 7.1-7.6)**}, **[12 Lectures]**

Recommended Text Books:

[1]. S.S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall of India Private Ltd. (2004).

Reference Books:

[1]. M. K. Jain, S.R.K. Iyenger and R.K. Jain,Numerical Methods for Scientific and Engineering Computations, 6th Edition, New Age International Publication (P) Ltd. (2012).
[2]. Erwin Kreyszig, Advanced Engineering Mathematics, 2nd Edition, John Wiley & Sons, INC. (2005).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT205.1	Practice common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems	3
MT205.2	Explain numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of system of equations, and the solution of differential equations.	4
MT205.3	Write efficient, well-documented C++ code and present numerical results in an informative way	3

MT-206: PRACTICAL-II

Course objectives:

The objectives of this course are

1) To write, understand C++ program codes for finding the approximate solution of transcendental equations.
2) To write, understand C++ program codes for finding the approximate solution of system of equation and to find spectral radius of given matrix using power method.
3) To write, understand C++ program codes to solve the given initial value problem and to evaluate given integration.

List of C++ Programs to be coved under this practical course

Write programs based of following methods:

1. Simple Bisection method
2. Bisection with tests for convergence
3. Recursive solution for Bisection
4. Newton's method
5. Secant Method
6. Polynomial interpolation
7. Estimating Derivatives
8. Regula – Falsi method
9. Muller method
10. Gauss elimination method
11. Gauss-Seidal method

12. Gauss-Jacobi method
13. Power method
14. Euler method
15. Runge-Kutta second order method
16. Runge-Kutta fourth order method
17. Trapezoidal rule
18. Simpson's 1/3rd rule
19. Simpson's 3/8th rule

Course outcomes:
After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT206.1	Reframe C++ program codes for finding the approximate solution of transcendental equations by Bisection, Regula-Falsi, Secant, Newton Raphson method.	5
MT206.2	Understand C++ program codes for finding the approximate solution of system of equations by Gauss-Seidal, Gauss-Jacobi and to find spectral radius of given matrix using power method.	6
MT206.3	Construct C++ program codes to solve the given initial value problem by using Euler, Runge-Kutta methods and to evaluate given integration by Trapezoidal, Simpsons rules.	3

AC-201(A): SOFT SKILLS

Course objectives:
1) To inculcate different soft skills among students

Unit 1. Introduction to soft skills (02 Hrs)

Formal definition, Elements of soft skills, Soft vs. Hard skills, Emotional quotient, Goal setting, life skills, Need for soft skills, Communication skills, Etiquettes& Mannerism.

Unit 2. Self Assessment(04 Hrs)

Goal setting, SWOT analysis, attitude, moral values, self confidence, etiquettes, non-verbal skills, achievements, positive attitude, positive thinking and self esteem.

Activity: The teacher should prepare a questionnaire which evaluate students in all the above areas and make them aware about these aspects.

Unit 3. Communication Skills (08 Hrs)

Types of communication: Verbal, Non-verbal, body language, gestures, postures, gait, dressing sense, facial expressions, peculiarity of speaker (habits).

Rhetoric speech: Prepared speech (topics are given in advance, students get 10 minutes to prepare the speech and 5 minutes to deliver, Extempore speech (students deliver speeches spontaneously for 5 minutes each on a given topic), Storytelling (Each student narrates a fictional or real life story for 5 minutes each), Oral review (Each student orally presents a review on a story or a book read by them)

Drafting skills: Letter, Report & Resume writing, business letters, reading & listening skills

Activity: The teacher should teach the students how to write the letter, report and build resume. The teacher should give proper format and layouts. Each student will write one formal letter, one report and a resume.

Unit 4. Formal Group Discussion, Personal Interview & Presentation skills (04 Hrs)

Topic comprehension, Content organization, Group speaking etiquettes, driving the discussion & skills.

Preparation for personal interview: dress code, greeting the panel, crisp self-introduction, neatness, etiquettes, language tone, handling embarrassing & tricky questions, graceful closing.

Activity: Each batch is divided into two groups of 12 to 14 students each. Two rounds of a GD for each group should be conducted and teacher should give them feedback. Mock interview are to be conducted.

Unit 5. Aptitude and analytical skills (08 Hrs)

Quantitative aptitude, Numerical reasoning, verbal reasoning, diagrammatic test, situational tests, logical thinking.

Analytical skills: Definition, Types, problem solving

Unit 6. Life skills(04 Hrs)

Time management, critical thinking, sound and practical decision making by dealing with conflicts, stress management, leadership qualities

Activity: The teacher can conduct a case study activity to train students for decision making skills. The teacher should conduct a session on stress management and guide students on how to manage stress. The teacher may conduct a stress relieving activity in the class. He/she may counsel students individually to know their problems and guide them on dealing with them effectively.

Books:

1. Basics of Communication In English: Francis Sounderaj, MacMillan India Ltd.
2. English for Business Communication: Simon Sweeney, Cambridge University Press
3. An Introduction to Professional English and Soft Skills: Das, Cambridge University Press
4. Quantitative Aptitude: R.S. Agrawal

Course outcomes:

After the completion of the course, students will be able to;

Course Outcome	Course Outcome	Cognitive Level
AC201(A).1	Identify their lacunas about some soft skills and try to overcome the same	1
AC201(A).2	Practice learned soft skills in real life and do their jobs more effectively	3

AC-201(B): PRACTICING SPORTS ACTIVITIES

Course objectives:

1) To motivate students towards sports and provide them required training

SR NO.	NAME OF THE SPORT/GAME (Select ONE of the Following)	SYLLABUS OF THE COURSE	TIMING (02 Hours in a Week)	SEMESTER
1	Volleyball	• General Fitness • Basic Fitness • Specific Fitness • History of the Game • Basic Skill of the Game • Major Skill of the Game • Technique & Tactics of the Game • Game Practice	Morning : 07 to 09 AM OR Evening : 05 to 07 PM	Total 30 Hours in Each Semester
2	Athletics			
3	Badminton			
4	Cricket			
5	Basketball			
6	Handball			
7	Kabaddi			
8	Kho-Kho			
9	Table-Tennis			
10	Swimming			

Course outcomes:

Course Outcome	Course Outcome	Cognitive Level
AC201(B).1	Identify one or more sports of their choice and develop more interest to participate at University/National level sport events	1
AC201(B).2	Practice the learned sports activities regularly in real life	3

AC-201(C): PRACTICING YOGA

Course objectives:

1) To motivate students towards yoga and provide them required training

- Yog:Meaning, Definition & Introduction, Objectives
- Primary Introduction of Ashtanga Yoga
- Preparation of Yogabhyas
- OmkarSadhana, Prayer, Guru Vandana
- SukshmaVyayamas
- Suryanamaskar(12 Postures)
- Asanas :
  - Sitting (Baithaksthiti) -Vajrasana, Padmasan,Vakrasan,Ardha-Pashchimotanasanan
  - Supine (Shayansthiti) - UttanPadaasan(Ekpad/Dwipad), Pavanmuktasana, ViparitakaraniAasan, Khandarasan, Shavasana
  - Prone (Viparitshayansthiti) - Vakrahasta,Bhujangasana, SaralhastaBhujangasana, Shalabhasana(Ekpad/Dwipad), Makarasana
  - Standing (Dhandsthiti) - Tadasana , TiryakTadasana, Virasana,ArdhChakrasana
- Primary Study of Swasana: Dirghaswasana, Santhaswasana, JaladSwasana - 6 Types
- Pranayama : Anuloma-viloma, Bhramari

Course outcomes:

After the completion of the course, students will be able to;

Course Outcome	Course Outcome	Cognitive Level
AC201(C).1	Identify and practice some Yoga asanas regularly in their life to remain healthy	2
AC201(C).2	Provide guidance and practice about Yoga to their friends, parents and relatives	3

AC-201(D): INTRODUCTION TO INDIAN MUSIC

Course objectives:

1) To motivate students towards Indian music and provide them minimum required training

- Definition and brief about generation of Swar, Saptak, Thaat, Raag, Aavartan, Meend, Khatka, Murkee, Taal, Aalaap etc.
- Taal and its uses - Treetaal, Daadraa, Zaptaal, Kervaa.
- Information of Badaakhyaal, Chhotaakhyaal (one), Sargam, Lakshangeet (information)
- Detailed information of Tambora
- Detailed information of Harmonium and Tablaa.
- Five filmy songs based on Indian Classical Music (Theory and Presentation)
- Sound Management - Basic information of Sound Recording (including Practicals)
- Composition of Music as per the Story

- Preparing news write-ups of the Seminars, Library Musical Programmes held at the nearest Akashwani, by personal visits.

Course outcomes:

After the completion of the course, students will be able to;

Course Outcome	Course Outcome	Cognitive Level
AC201(D).1	Identify different types of Indian music	3
AC201(D).2	Develop more interest to learn and practice Indian music	4

MT 301: FUNCTIONAL ANALYSIS

Course objectives:

The objectives of this course are

1) to make students aware of the concepts of normed spaces, Banach space and Hilbert spaces
2) to explain how the notion of norm induces metric on a linear space and there we can think of sequences, continuity and completeness over linear spaces
3) apply uniform boundedness principal, Hahn-Banach theorem for solution of differential equations
4) to explain Riesz-representation theorem its importance and natural existence of adjointoperator and their relationship with self-adjoint, unitary and normal operators.

Unit I: Fundamental of Normed spaces

Normed spaces, Continuity of linear maps, Hahn - Banach theorems.

{Chapter II [1], (5, 6, 7)} [12 Lectures]

Unit II: Banach spaces and Bounded Linear Maps

Banach Spaces, Uniform bounded principle.

{Chapter II [1], (8) & Chapter III [1], (9)} [12 Lectures]

Unit III: Open Mapping Theorem

Closed graph theorem, Open mapping theorem, Bounded inverse theorem.

{Chapter III [1], (10, 11)} [12 Lectures]

Unit IV: Hilbert spaces

Inner product spaces, orthonormal sets, Projection and Riesz representation theorem.

{Chapter VI [1], (21, 22, 24)} [12 Lectures]

Unit V: Bounded Operators on Hilbert Spaces

Bounded operators, Adjoint, Normal, Unitary and Self Adjoint Operators.

{Chapter VII [1], (25, 26)} [12 Lectures]

Recommended Text Book:

[1] B. V. Limaye, Functional Analysis, New Age International Limited, New Delhi (1996).

Reference Books:

[1] Erwin Kreyszig, Introductory Functional Analysis with Applications, John Wiley (2007).

[2] G. F. Simmon, Introduction to General Topology and Modern Analysis, Mc-Graw Hill (2004).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT301.1	Discuss normed spaces, subspaces, continuity, Banach spaces and Hilbert spaces.	2
MT301.2	Analyze eight equivalent conditions of continuity on normed spaces and Banach spaces	4
MT301.3	Sketch the proof of uniform boundedness principle, closed graph theorem, open mapping theorem, Hahn Banach theorem and its extension	3
MT301.4	Classify operators on Banach spaces	4

MT-302: PARTIAL DIFFERENTIAL EQUATIONS

Course objectives:

The objectives of this course are

1) Apply a range of techniques to solve partial differential equations first order and second order.
2) Exposed to Charpit's Method, Jacobi Method and solve wave equation, heat equation, Laplace Equation.
3) Learn classification of Partial Differential Equation and handle boundary value problems.

Unit I: Partial Differential Equations of First Order

First order PDE, classification of integrals, Linear equations of first order, Pfaffian differential equations, compatible systems, Cauchy Problem, Integral surfaces through a given curve for partial differential equations, Charpit's method, Jacobi's method. [**15 Lectures**]

Unit II: Partial Differential Equations of Second Order

Origin of second order partial differential equation, Linear equations with constant coefficients, Equations with variable coefficients, Method of separation of variables, Nonlinear equations of the second order. [**15 Lectures**]

Unit III: Laplace Equation

The occurrence of Laplace's equation in physics, Elementary solution of Laplace's equation, Families of equipotential surfaces, Boundary value problems, Method of separation of variables, Problems with axial symmetry. [**10 Lectures**]

Unit IV: The Wave Equation

The occurrence of wave equation in physics, Elementary solutions of the one-dimensional wave equation, Riemann-Volterra solution of the one-dimensional wave equation, Method of separation of variables. [**12 Lectures**]

Unit V: The Diffusion Equation

The occurrence of the diffusion equation in physics, Elementary solutions of the diffusion equation, Separation of variables. [**08 Lectures**]

Recommended Text Book:

[1] I. N. Sneddon: Elements of Partial Differential Equations, McGraw Hill Book Company, (1957).

Reference Books:

[1] T. Amarnath: An elementary course in Partial differential equations, Narosa Publishing House, 2nd Edition, (2011).
[2] F. John: Partial Differential Equations, Springer-Verlag, New York, (1982).
[3] D. Bleecker and G. Csordas: Basic Partial Differential Equations, Van Nostrand Reinhold, New York, (1992).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT302.1	Solve the first-order linear and non-linear partial differential equations by using Lagrange's and Charpit'smethods respectively.	3
MT302.2	Evaluate the solutions of linear partial differential equations of second and higher order with constant coefficients.	5
MT302.3	Classify second order PDE Classify the fundamental principles of partial differential equationsto solve hyperbolic, parabolic and elliptic equations and solve standard partial differential equations using separation of variable method.	4

MT-303 (A): CLASSICAL MECHANICS

Course objectives:

The objectives of this course are

1) The students will learn Euler's variational principles and will use to solve real life problems.
2) To learn how to use D'Alembert's Principle, Lagrange's equation, Hamiltonians Principle, Hamilton's equation and Hamilton Jacobi equation to form differential equation as well as its solution of various real existing systems.
3) To introduce Poisson's brackets, Lagrange's bracket, canonical transformation etc.

Unit I: Variational Problems with Fixed and Boundaries

Variation and its properties, Euler's equation, Variational problems for functional of the form, Functional dependent on Higher order derivatives, Functional dependent on functions on several independent variables, Variational problems in parametric form, Variational problem with a movable boundary for a functional dependent on two functions. **([2], Chap 1: 1.1 to 1.6, Chap 2: 2.1, 2.2)**[**16 Lectures**]

Unit II: Survey of the Elementary Principle

Mechanics of a particle and system of particle, Constraints, D'Alembert's principle and Lagrange's equation, Velocity-dependent potential and the dissipation function, Simple applications of the Lagrangian formulation.

([1], Chap 1: 1 to 6) **[10 Lectures]**

Unit III: Variational Principles and Lagrange's Equation

Hamilton's principle, Derivation of Lagrange's equations from Hamilton's principle, Extension of Hamilton's principle to nonholonomic system, Conservation theorems and symmetry properties. **([1], Chap 2: 1 to 6) [10 Lectures]**

Unit IV: The Hamilton Equation of Motion

Legendre transformations and the Hamilton equations of motion, Cyclic coordinates and conservation theorems, Routh's procedure and oscillations about steady motion, Derivation of Hamilton's equation from a variational principle, The principle of least action. **([1], Chap 8: 1 to 3, 5,6)** [**10 Lectures**]

Unit V: Canonical Transformations

The equations of canonical transformation, Examples of canonical transformations, Poisson brackets and other canonical invariants, Equations of motion, infinitesimal canonical transformations and conservations theorems in the poisons bracket formulation. **([1], Chap 9: 1, 2, 4, 5)** [**08 Lectures**]

Unit VI: Hamilton-Jacobi Theory

Hamilton-Jacobi equation for Hamilton's principle function, The Harmonic oscillator problem as an example of the Hamilton-Jacobi method.

([1], Chap 10: 1 to 2) [**06 Lectures**]

Recommended Text Books:

[1] Herbert Goldstein, Classical Mechanics, Narosa Publishing House, (1993) (Reprint).
[2] A. S. Gupta, Calculus of Variation with Application, Prentice-Hall of India Private Limited, (2005).

Reference Books:

[1] G. Aruldhas, Classical Mechanics, Phi learning Pvt Ltd (First Edition), (2009).
[2] Madhumangal Pal, A Course on Classical Mechanics, Narosa Book Distributors Private Ltd, (2008).
[3] L. N. Katkar, Problems in Classical Mechanics, Alpha Science International Ltd (2 April 2014).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT303(A).1	Apply the Variational principles to real physicalproblems.	3
MT303(A).2	Develop mechanical systems, both in inertial and rotating frames, using Lagrange and Hamilton equations.	3
MT303(A).3	Describe the motion of a mechanical system using Hamilton-Jacobi equation.	2
MT303(A).4	Convince the mechanism of canonical transformation.	5

MT-303 (B): ALGEBRAIC CODING THEORY

Course objectives:

The objectives of this course are

1) The aim of this course is to train the students in the knowledge of the actual mathematics used in algebraic coding theory.

2) They will learn to detect and correct error patterns using polynomial codes, Hamming codes, BCH codes, linear codes and cyclic codes.
3) The students will learn the most modern applications and will be able to follow new research in engineering security and coding theory.

Unit-I Group codes:
Elementary properties, Matrix encoding techniques, Generator and parity check matrices. [08 Lectures]

Unit-II Polynomial codes:
Definition of vector space and polynomial ring, Polynomial codes, Generator and parity check matrices-general case. **[10 Lectures]**

Unit-III Hamming codes:
Binary representation of numbers, Hamming codes. **[06 Lectures]**

Unit-IV Finite fields and BCH codes:
Finite fields, Some examples of primitive polynomials, Bose-Chaudhuri-Hocquenghem codes. **[12 Lectures]**

Unit-V Linear codes:
Generator and parity check matrices, Dual code of a linear code, Weight distribution of the dual code of a binary linear code, New codes obtained from given codes. **[12 Lectures]**

Unit-VI Cyclic codes:
Cyclic Codes, Check polynomial, BCH and Hamming codes as cyclic codes, Non-binary Hamming codes, Idempotents, Some solved examples and an invariance property, Cyclic codes and group codes and group algebras, Self-dual binary cyclic codes. **[12 Lectures]**

Recommended Text Book:
[1] Lekh R. Vermani, Elements of Algebraic Coding Theory, Chapman & Hall Mathematics (1996). [Chapters 1 to 6]

Reference Books:
[1] Raymond Hill, A first course in coding Theory, Oxford University Press (1990).
[2] Shu Lin and Daniel Costello, Error Control Coding" (2nd Edition), Pearson.
[3] RudigerUrbanke and Thomas Richardson, Modern Coding Theory, Cambridge.
[4] F. J. MacWilliams and N. J. A. Salone, The theory of error-correcting codes, North-Holland publishers.

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT303(B).1	Recite mathematics on finite fields	1
MT303(B).2	Examine new algorithms for algebraic coding theory.	3
MT303(B).3	Test the current developments in coding theory and can select a topic for their research work.	5

MT-303 (C): SPECIAL FUNCTIONS

Course objectives:

The objectives of this course are

1) To analyze properties of special functions by their integral representations and symmetries.
2) To determine properties of Legendre polynomials, Rodrigue'sformula,generatingfunction and Fourier Legendre's serieswhich may be solved by application of special functions.
3) To determine properties of solution of Bessel's differential equation and Bessel's functions, Bessel's function of first kind and second kind, Orthogonality of Bessel's functions, The Hypergeometric Functions.
4) Study of Hypergeometric series, Euler's Integral Representation, the Hypergeometric equation, the Barnes Integral for the Hypergeometric function

Unit I: The Gamma & Beta Functions:

The Gamma and Beta integrals, Functions and their properties, The Euler Reflection formula, Riemann Zeta functions, Gauss's multiplication formula for $\Gamma(mx)$, Integral representation for Log $\Gamma(mx)$, The Bohr-Mollerup theorem.

{[1] Chapter 1; 1.1, 1.2, 1.3, 1.5, 1.6, 1.9} [**15 lectures**]

Unit II: Legendre Polynomials:

Solution of Legendre differential equation and Legendre polynomials, Rodrigue's formula, Generating function, Recurrence relations, Orthogonal and orthonormal functions, Orthogonal property of Legendre's polynomials, Fourier Legendre's series.

{[2] Chapter 7; 7.1, 7.2, [3] Chapter 4; 4.2} [**15 lectures**]

Unit III: Bessel's Functions:

Solution of Bessel's differential equation and Bessel's functions, Bessel's function of first kind and second kind, Orthogonality of Bessel's functions, Fourier Bessel's series.

{[2] Chapter 7; 7.4, 7.5, [3] Chapter 3; 3.2} [**15 lectures**]

Unit IV: The Hypergeometric Functions:

The Hypergeometric series, Euler's Integral Representation, the Hypergeometric equation, the Barnes Integral for the Hypergeometric function. {[1] Chapter 2; 2.1, 2.2, 2.3, 2.4} [**15 lectures**]

Recommended Text Books:

[1] George E. Andrews, Richard Askey, Ranjana Roy, Special Functions, Cambridge University Press, (2010).
[2] R. K. Jain and S. R. K. Iyengar Advanced Engineering Mathematics, Narosa Publishing House, New Delhi, (2008).
[3] Mark A. Pinsky, Partial Differential Equations and Boundary Value Problem with Applications, McGraw-Hill, Ins. (1991).

Reference Books:

[1] Earl D. Rainville, Special Functions, Chelsea Publishing Company, New York, (1960).
[2] H. M. Srivastava, A Treatise, On Generating Functions, John Wiley & Sons, New York.

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT303(C).1	List the basic concept of integral calculus and special functions of various engineering problem and to know the application of some basic mathematical methods via all these special functions.	1
MT303(C).2	Explain the applications and the usefulness of these special functions.	3
MT303(C).3	Justify the use of gamma function, beta function special functions, Hypergeometric function and Hypergeometric series to: evaluate different types of integral calculus problems and solve differential equations.	5

MT-303 (D): ADVANCED CALCULUS

Course objectives:

The objectives of this course are

1) Introduce basic concepts from Compact and connected subsets of $\mathbb{R}^n$, derivative, continuous differentiable functions, chain rule, line, surface and volume integrals.
2) State the theorems and outline their proofs: Inverse function theorem, Implicit function theorem, Green's theorem, Change of variable theorem, in the plane, The Soundness Theorem, The Completeness Theorem and Gauss divergence theorem.
3) Evaluate the Integral over a rectangle, Integral over a bounded set, improper integrals, line integrals and double integrals.

Unit I: Topology of $\mathbb{R}^n$

Compact and connected subsets of $\mathbb{R}^n$. [**10 Lectures**]

Unit II: Differentiation

Derivative, Continuous differentiable functions, Chain rule, Inverse function theorem (Statement only), Implicit function theorem (Statement only). [**10 Lectures**]

Unit III: Integration

Integral over a rectangle, Existence of the integral, Evaluation of the integral, Integral over a bounded set, Rectifiable sets, Improper integrals. [**10 Lectures**]

Unit IV: Change of Variables

Change of variable theorem (proof of one variable), Statement of $n-$variables (with illustrations). [**10 Lectures**]

Unit V: Line, Surface and Volume Integrals

Line integrals, Double integrals, Applications to area and volume, Green's theorem in the plane, Change of variables in a double integral, Area of parameter surface, Surface integral, Stokes theorem, Gauss divergence theorem and applications. [**20 Lectures**]

Recommended Text Books:

[1] J. R. Munkres: Analysis on Manifold, Addition Wesley Pub. Co., (1991). (Sections 3 to 15 and 17 for Units I to IV)
[2] T. M. Apostol: Calculus (Vol. II), Second Edition, John Wiley and Sons, Inc., (1969). (Unit V)

Reference Books:

[1] Walter Rudin: Principles of Mathematical Analysis, McGraw-Hill Book Company, 3rd Edition (2013).
[2] T. M. Apostol: Mathematical Analysis, Narosa Publishing House, 2nd Edition (1977).
[3] David Widder: Advanced Calculus, Prentice Hall; 2nd Revised Edition, (1961).
[4] M. R. Spiegel: Advanced Calculus, Schaum's Outline Series, Mc-Graw Hill Book Company, (1974).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT303(D).1	Compute the continuity, Integral and differentiability of a function, and line, surface and volume Integrals.	3
MT303(D).2	Produce various results in $\mathbb{R}^n$ and know how to use for finding line, double, surface and volume Integrals.	3
MT303(D).3	Explain Stokes and Greens theorems along with their applications	4

MT- 303 (E): DIFFERENTIAL GEOMETRY

Course objectives:

The objectives of this course are

1) The student should be able to understand the fundamental theorem for calculus on Euclidean space and plane curve.
2) They will understand the notion of Serret-Frenet frame for space curves and the involutes and evolutes of space curves with the help of examples.
3) The students will be able to compute the curvature and torsion of space curves and will understand the fundamental theorem for space curves. Course outcomes

Unit I: Calculus on Euclidean Space

Euclidean Space, Tangent Vectors, Directional Derivatives, Curves in E^3, 1-Forms, Differential Forms, Mappings. [**08 Lectures]**

Unit II: Frame Fields

Dot Product, Curves, TheFrenet Formulas, Arbitrary-Speed Curves, Covariant Derivatives, Frame Fields, Connection Forms. [**12 Lectures]**

Unit III: Euclidean Geometry

Isometries of E^3, The Derivative Map of an Isometry, Orientation, Euclidean Geometry, Congruence of Curves. **[12 Lectures]**

Unit IV: Calculus on a Surface

Surfaces in E^3 , Patch Computations, Differentiable Functions and Tangent Vectors, Differential Forms on a Surface, Mappings of Surfaces, Integration of Forms.

[12 Lectures]

Unit V: Shape Operators and Riemannian Geometry

The Shape Operator of M C E^3, Normal Curvature, Gaussian Curvature, Computational Techniques, Special Curves in a Surface, Surfaces of Revolution, Geometric Surfaces, Gaussian Curvature, Covariant Derivative, Geodesies.

[16 Lectures]

Recommended Text Book:

[1] O'Neill, B., Elementary Differential geometry, Academic Press, London 1966.

Reference Books:

[1] Millman, R. and Parker, G.D., Elements of differential geometry: Prentice-Hall of India Pvt. Ltd. 1977
[2] Hicks, N., Notes of differential geometry, Princeton University Press (1968)
[3] Nirmala Prakash, Differential Geometry, Tata McGraw-Hill 1981

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT303(E).1	Explain the concepts and language of differential geometry and its role in modern mathematics	3
MT303(E).2	Focus on important results and theorems covered by the course.	4
MT303(E).3	Calculate the curvature and torsion of a curve and calculate the first and the second fundamental forms of a surface.	4

MT-304 (A): GRAPH THEORY

Course objectives:

The objectives of this course are

1) Explain basic concepts in graph theory and define how graphs serve as models for many standard problems
2) Discuss the concept of graph, tree, Euler graph, cut set and coloring of graphs.
3) See the applications of graphs in science, business and industry.

Unit-I: Graphs, Paths and Circuits

Graph, Finite and Infinite Graphs, Incidence and Degree, Isolated Vertex, Pendant Vertex, and Null Graph, Isomorphism, Subgraphs, Walks, Paths, and Circuits, Connected Graphs, Disconnected Graphs, and Components, Euler Graphs, Operations on Graphs, More on Euler Graphs, Hamiltonian Paths and Circuits, The Traveling Salesman Problem.

{Chapter 1 [1], Art. 1.1-1.6, and Chapter 2 [1], Art. 2.1-2.10} **[15 Lectures]**

Unit-II: Trees and Cut-Sets

Trees, Some Properties of Trees, Pendant Vertices in a Tree, Distance and Centers in a Tree, Rooted and Binary Trees, On Counting Trees, Spanning Trees, Fundamental Circuits, Finding All Spanning Trees of a Graph, Spanning Trees in a Weighted Graph, Cut-Sets, Some Properties of a Cut-Set, All Cut-Sets in a Graph, Fundamental Circuits and Cut-Sets, Connectivity and Separability, 1-Isomorphism, 2-Isomorphism.

{Chapter 3 [1], Art. 3.1-3.10 and Chapter 4 [1], Art. 4.1-4.8} **[15 Lectures]**

Unit-III: Planar Graphs and Matrix Representation

Planar Graphs, Kuratowski's Two Graphs, Different Representations of a Planar Graph, Detection of Planarity, Geometric Dual, Combinatorial Dual, Incidence Matrix, Submatrices of $A(G)$, Circuit Matrix, Fundamental Circuit Matrix and Rank of B, Cut-Set Matrix, Relationships among A_f, B_f, C_f, Path Matrix, Adjacency Matrix. {Chapter 5 [1], Art. 5.1-5.7 and Chapter 7 [1], Art. 7.1-7.9}

[15 Lectures]

Unit-IV: Coloring, Covering and Partitioning

Chromatic Number, Chromatic Partitioning, Chromatic Polynomial, Matchings, Coverings, The Four-Color Problem. {Chapter 8 [1], Art. 8.1-8.6} **[07 Lectures]**

Unit-V: Directed Graphs

Directed Graph, Some Types of Digraphs, Digraphs and Binary Relations, Directed Paths and Connectedness, Euler Digraphs, Trees with Directed Edges, Fundamental Circuits in Digraphs, Matrices A, B, and C of Digraphs, Adjacency Matrix of a Digraph. {Chapter 9 [1], Art. 9.1-9.11} **[08 Lectures]**

Recommended Text Book:

[1] N. Deo, Graph Theory with applications to Engineering and Computer Science, Prentice Hall of India (2015).

Reference Books:

[1] Douglas B. West, Introduction to Graph Theory Prentice- Hall, New Delhi (1999).
[2] John Clarke and D.A. Holton, A First Look at Graph Theory, Allied Publisher (1991).
[3] Nora Harsfield and Gerhard Ringel , Pearls Theory, Academic Press (1990).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT304(A).1	Explain the basic concepts of graph theory.	3
MT304(A).2	Correlate use of graphs as models and various types of graphs such as trees, planar graphs, Euler graphs, Hamiltonian graph and directed graph.	4
MT304(A).3	Solve some real time problems using concepts of graph theory and may work for research degree in the subject.	6

MT-304 (B): STABILITY THEORY

Course objectives:

The objectives of this course are

1) To introduce the concept of linear and nonlinear dynamical systems.
2) To learn the basic ideas and methods associated with dynamical systems, like, evolution of system, fixed points, periodic points, attractors, bifurcation process and stability of the systems.
3) To understand the nonlinearity in nature and study of the nonlinear models in engineering and its dynamics
4) Use MATLAB and Simulink for solving dissipative dynamical systems which are more relevant to the engineering problem.

Unit I: Linear Systems:

Coupled and uncoupled systems, fundamental theorem, Linear System in $\mathbb{R}^2$, phase space, Phase portrait, Critical points classification, Complex eigenvalues. {[1] Chapter-1: 1.1, 1.2, 1.4-1.9} [**15 Lectures**]

Unit II: Nonlinear Systems:

Critical points of nonlinear systems, maximum interval of existence, Flow defined by differential equations, Linearization, Stable manifold theorem, Center manifold theorem, Stability and Liapunov functions. {[1] Chapter-2: 2.4-2.9} [**15 Lectures**]

Unit III: Stability and Perturbation Theory:

Asymptotic stability & instability solutions, Stability of periodic solution of autonomous equations, Introduction to perturbation theory, Näive expansion, Poincare theorem. {[2] Chapter-7: 7.1-7.3, Chapter-9: 9.1-9.3} [**15 Lectures**]

Unit IV: Bifurcations:

Saddle node bifurcation, Andronov-Hopf bifurcation, Saddle connections, Semi stable limit cycle, Bifurcation in one parameter families.

{[3] Chapter-9: 9.1-9.4}[**15 Lectures**]

Recommended Text Books:

[1] Lawrence Perko, Differential Equations and Dynamical Systems, Springer-Verlag (1998).
[2] Ferdinand Verhulst, Nonlinear Differential Equations and Dynamical Systems, Springer-Verlag (2000).
[3] J. H. Hubbard and B. H. West, Differential Equations: A Dynamical System Approach (Higher Dimensional Systems), Springer-Verlag (1995).

Reference Books:

[1] Hahn, Stability of Motion, Springer-Verlag.
[2] T. A. Burton, Periodic Solutions of Ordinary and Fundamental Differential Equations, Academic Press (1985).
[3] David R. Merkin, *Introduction to the Theory of Stability,* Springer-Verlag.

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT304(B).1	Construct phase portraits of nonlinear system and understanding of fundamental difference between linear and nonlinear systems.	3
MT304(B).1	Classify fixed points, periodic points and limits cycles and determine their stability.	4
MT304(B).1	Distinguish attractors, saddle connections, semi stable limit cycle, bifurcation and its application to various engineering models.	4

MT-304 (C): PROBABILITY THEORY

Course objectives:

The objectives of this course are

1) Providing students with a formal and basic treatment of probability theory.
2) Equipping students with essential tools for statistical analysis and will understand the concept of random variable and jointly distributed random variables.
3) Fostering understanding through real-world statistical applications.

Unit I: Introduction to Probability Theory

Introduction, Sample Space and Events, Probabilities Defined on Events, Conditional Probabilities Independent Events, Bayes' Formula. {1 [chapter 1 (1.1-1.6)]}

[12 Lectures]

Unit II:Random Variables

Discrete Random Variables (The Bernoulli, The Binomial, The Geometric, The Poisson), Continuous Random Variables (The Uniform, Exponential, Gamma, Normal), Expectation of a Random Variable (The Discrete Case, The Continuous Case), Expectation of a Function of a Random Variables. {1 [chapter 2 (2.1-2.4)]}

[12 Lectures]

Unit III: Jointly Distributed Random Variables

Joint Distribution Functions, Independent Random Variables, Joint Probability Distribution of Functions of Random variables, Moment Generating Functions, Limit Theorems. {1[chapter 2 (2.5-2.7)]} **[12 Lectures]**

Unit IV: Conditional Probability and Conditional Expectation

Introduction, The Discrete Case, The Continuous Case. {1[chapter 3 (3.1-3.3)]

[12 Lectures]

Unit V: Computing

Computing Expectations by Conditioning, Computing Variances by Conditioning, Computing Probabilities by Conditioning, Some Applications, A List Model, A Random Graph, Uniform Priors, Polya's Urn Model, and Bose–Einstein Statistics. {1[chapter 3 (3.4-3.6)]} **[12 Lectures]**

Recommended Text Book:

[1] Sheldon Ross: Introduction to Probability Models *Tenth Edition*, Academic Press, 2010.

Reference Books:

[1] Hoel, P. G., Port, S. C. and Stone, C. J, Introduction to Probability Theory, Universal Book Stall, New Delhi, Reprint 2003.
[2] Chung, K. L., A Course in Probability Theory, Academic Press, San Diego, USA, 2001.
[3] Pierre Bremaud, An Introduction to Probabilistic Modeling, Springer, 1998.

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT304(C).1	Reproduce elementary probability theory and its application.	1
MT304(C).1	Explain the concept of a statistical distribution.	2
MT304(C).1	Apply selected probability distributions to solve problems.	3

MT-304 (D): LATTICE THEORY

Course objectives:

The objectives of this course are
1) demonstrate relation between lattices and Banach algebra
2) characterize distributive, modular and pseudo complemented lattices
3) explain relation between natural elements and ideal theory.

Unit I: First Concepts

Two Definitions of Lattices, How to Describe Lattices, Some Algebraic Concepts, Inequalities, Special Elements. {Chapter 1[1] (1, 2, 3, 4,6)} [**20 Lectures**]

Unit II: Distributive and Modular Lattices

Characterization Theorems and Representation Theorems, Congruence Relations, Boolean Algebras R-generated by Distributive Lattices, Distributive Lattices with Pseudocomplementation. {Chapter 2[1] (1, 3, 4,6)} [**20 Lectures**]

Unit III: Congruences and Ideals

Congruences, Standard and Neutral Elements, Standard. and Neutral Ideals, Structure. {Chapter 3[1] (2, 3, 4)} [**20 Lectures**]

Recommended Book:

[1] George Gratzer, General Lattice Theory, Pure and Applied Maths. Ser. Academic Press, New York, 1978.

Reference Books:

[1] George Gratzer, Lattice Theory: First concepts and distributive lattices, W. H. Freeman and company, San Francisco, 1971.
[2] G. Birkhoffs, Lattice theory, Amer. Math. Soc. Coll. Publications, Third Edition 1973.

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT304(D).1	Describe concepts of lattice, Boolean algebra, distributive lattice, modular lattice and ideals.	2
MT304(D).2	Construct example of lattices, maximal, minimal elements, atoms, pseudo complemented elements, prime and maximal ideals.	3
MT304(D).3	Illustrate relationship lattice and Boolean algebra, distributive and modular lattices, prime ideal and maximal ideals. Also, the necessary and sufficient conditions for distributive and modular lattices.	3
MT304(D).4	Explain the proof of the Stone's representation theorem and relationship between the maximal ideals and the set of points of a topological space.	4

MT-304 (E): ALGEBRAIC TOPOLOGY

Course objectives:

The objectives of this course are

1) To introduce definition and properties of homotopic mappings, relative homotopy, contractible spaces, homotopy type, retractions, path connected spaces, equivalent paths.
2) To acquaint the isomorphism and homomorphism of fundamental group, induced homomorphism, introduction to fundamental group of the circles, lifting lemma, covering homotopy lemma.
3) To keen study of G-spaces, properties of covering maps, fundamental group of the covering space, geometric simplexes and complexes geometrically independent set.

Unit I: Homotopy and Paths

Category, Functions, Definition and properties of Homotopic mappings, Relative Homotopy, Contractible spaces, Homotopy type, Retractions. Path connected spaces, Equivalent paths. [**15 Lectures**]

Unit II: Fundamental Groups:

Formation of a group, Isomorphism of fundamental groups, Homomorphism of fundamental groups, Induced homomorphism, Introduction to fundamental group of

the circles, Lifting lemma, Covering Homotopy lemma, $\Pi_1(S^1)$ is isomorphic to the additive group of integers, Tours, Applications. [**15 Lectures**]

Unit III: Covering Spaces and Fibrations

Definitions, Local homeomorphism, G-spaces, Properties of covering maps, Fundamental group of the covering space, Unique path lifting, Fibrations and equivalent paths, covering map and Fibrations. [**15 Lectures**]

Unit IV: Geometric Simplexes and Complexes

Geometrically independent set, Simplexes, Orientation of simplexes, Complexes, Triangulation, Simplicial mapping, Topological dimension, The Brouwer fixed point theorem, Barycentric subdivision. [**15 Lectures**]

Recommended Text Book:

[1] Lahiri B. K., A First Course in Algebraic Topology, Second Edition, Narosa Publishing House, (2005) [Chapters 2 to 10].

Reference Books:

[1] Croom F. H., Basic Concepts in Algebraic Topology, Springer under Graduate Text.
[2] Singer I. M. and Thorpe J. A., Lecture Notes on Elementary Topology and Differential Geometry, Springer Verlag.
[3] Hatcher Allen, Algebraic Topology, Cambridge University Press
[4] Massey W. S., Algebraic Topology- An Introduction, Harcourt, Brace and World Inc. 1967, SV, 1977.
[5] Greenberg Marnim J. and Harper J. R., Algebraic Topology- A First Course, Addison-Wesley Publishing Co., 1981.

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT304(E).1	Recall the definition and properties of homotopic mappings, relative homotopy, contractible spaces, homotopy type, retractions, path connected spaces, equivalent paths.	1
MT304(E).2	Extend the isomorphism and homomorphism of fundamental group, induced homomorphism, introduction to fundamental group of the circles, lifting lemma, covering homotopy lemma.	2
MT304(E).3	Summarize the concept of G-spaces, properties of covering maps, fundamental group of the covering space, geometric simplexes and complexes geometrically independent set.	5

MT-305: PROGRAMMING IN MATLAB

Course objectives:

The objectives of this course are

1) to introduce the student's basic commands and programming in mathematical software MATLAB
2) to grasp basics of plotting of 2D, 3D graphs and surface plots in MATLAB
3) to make them experts in programming and for solutions of system of linear equation, symbolic solution of polynomial equations, differential equations, Integrations and numerical differentiation and integrations.

Unit I: MATLAB Environment

MATLAB windows, Variables, Working with Matrices, Saving Variables, Script M-files, Elementary Math functions, Trigonometric functions, Data analysis functions, Random numbers, Defining matrices, using the colon operator, Special values and functions. {Chapter 2 [1], Art. 2.1-2.3 and Chapter 3 [1], Art. 3.1-3.4} **[15 Lectures]**

Unit II: Plotting

Introduction, Two dimensional plots, Basic plotting, Line, color, and mark style, Axes scaling, Other types of two-dimensional plot, Three dimensional plotting, Three dimensional line plot, Surface plots. {Chapter 4 [1], Art. 4.1-4.4}**[10 Lectures]**

Unit III: Programming in MATLAB

Introduction, Problems with two variables, Input/output, User defined Input, Output options, Functions, Statement level control structures, Relational and logical operators, Loops. {Chapter 5 [1], Art. 5.1-5.4} **[10 Lectures]**

Unit IV: Matrix Computations

Matrix operations and functions, Solutions to system of linear equations, Special Matrices. {Chapter 6 [1], Art. 6.1-6.3} **[10 Lectures]**

Unit V: Symbolic Mathematics and Numerical Techniques

Symbolic Algebra, Equation Solving, Differentiation and Integration, Interpolation, Numerical Integration, Numerical Differentiation. {Chapter 7 [1], Art. 7.1-7.3 and Chapter 8 [1], Art. 8.1-8.5} **[15 Lectures]**

Recommended Text Book:

[1] Delores M. Etter, David C. Kuncicky and Holly Moore, Introduction to MATLAB, Dorling Kindersley (India) Pvt. Ltd. New Delhi, (2009).

Reference Books:

[1] Brian R. Hunt, Ronald L. Lipsman and Jonathan M. Rosenberg, A Guide to MATLAB, Cambridge University Press, (2008).

[2] Y. Kirani Singh and B. B. Chaudhari, MATLAB Programming, PHI Learning Private Ltd., New Delhi, (2010).

[3] RudraPratap, Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers, Oxford University Press, (2010).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT305.1	Explain the concept of MATLAB programming, user defined functions, for, while and if-else loops etc	2
MT305.2	solve system of equations, to solve problems such on area, volumes, range of an objects shots through gun, pressure of air in the UDF engine, calculation of compound interest, population which increase exponentially etc. and repents them graphically.	3

MT305.3	Evaluate solutions of linear equations, roots of polynomials, numerical solutions of differential equations, symbolic calculation such as variable handling, differentiation and integration of functions.	5

MT-306: PRACTICAL - III

Course objectives:

The objectives of this course are

1) to make the students experts in solving mathematical problems through MATLAB programming
2) to represents solutions of various equations graphically which indicate nature of the he problem as well as solutions
3) to solve differential and integral equations using techniques of symbolic expressions and numerical using MATLAB built in and user defined functions.

List of MATLAB Programs to be coved under this practicalscourse

1. Simple program in MATLAB for area.
2. Program for Use of linspace command.
3. Program for Calculate the Drag coefficient.
4. Program for vapor saturation pressure & for water diff.
5. Program for vapor saturation pressure & for water diff with graph.
6. Program for find the force acting on the balloon.
7. Program for find use max min function.
8. Program for find use men median function.
9. Program for find calculate the range of ballistics projectile.
10. Program for plot the bar graph and pie chart.
11. Find the cube of a number use of function.
12. Print matrix for calculate velocity acceleration distance with motions.
13. Nested if else for `temperature.
14. Find grade of score using function.
15. Find the factorial of number use of function fact ().
16. Find multiplication and power of matrix.
17. Find division of matrix.
18. Program for determine mass.
19. Solving simultaneous equation.
20. Use of symbolic expressions.
21. Use of Differentiation function.
22. Use of Integration function.

23. Use of Tic Toc function in program.
24. Program for solution of single PDE with constant coefficients
25. Program for solution of single PDE with constant coefficients
26. Program for solution of system of PDE with constant coefficients
27. Finite difference numerical explicit forwarded time centered space method for hyperbolic PDE
28. Finite difference numerical Von Neumann Method for hyperbolic PDE
29. Finite difference numerical Lax Method for hyperbolic PDE
30. Finite difference numerical Staggered Leapfrog method for hyperbolic PDE

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT306.1	Calculate the Drag coefficient, vapor saturation pressure & for water diff with graph, find the force acting on the balloon, find use max min function and calculate the range of ballistics projectile	4
MT306.2	Sketch the bar graph and pie chart, find the grade of students, cubes and factorial of a number using functions, nested if else, for loops, temperature, find multiplication, power of matrix, division of matrix	3
MT306.3	Solve simultaneous equations, Differentiation and integration function in single PDE with constant coefficients, system of PDE with constant coefficients using numeric techniques	6

AC-301(A): COMPUTER SKILLS

Course objectives:

1) To inculcate different daily useful computer skills among students

Unit 1: Elements of Information Technology (02 Hrs)

1.1 Information Types: Text, Audio, Video, and Image, storage formats
1.2 Components: Operating System, Hardware and Software, firmware
1.3 Devices: Computer, Mobile Phones, Tablet, Touch Screen, Scanner, Printer, Projector,smart boards
1.4 Processor & Memory: Processor functions, speed, Memory types:RAM/ROM/HDD/DVD-ROM/Flash drives, memory measurement metrics

Unit 2: Office Automation-Text Processing (05 Hrs)

2.1 Views: Normal View, Web Layout View, Print Layout View, Outline View, ReadingLayout View
2.2 Working with Files: Create New Documents, Open Existing Documents, SaveDocuments to different formats, Rename Documents, Close Documents

2.3 Working with Text: Type and Insert Text, Highlight Text, Formatting Text, Delete Text,Spelling and Grammar, paragraphs, indentation, margins
2.4 Lists: Bulleted and Numbered Lists,
2.5 Tables: Insert Tables, Draw Tables, Nested Tables, Insert Rows and Columns, Moveand Resize Tables, Moving the order of the column and/or rows inside a table, TableProperties
2.6 Page Margins, Gutter Margins, Indentations, Columns, Graphics, Print Documents,
2.7 Paragraph Formatting, Paragraph Attributes, Non-printing characters
2.8 Types of document files: RTF, PDF, DOCX etc

Unit 3: Office Automation-Worksheet Data Processing (05 Hrs)

3.1 Spreadsheet Basics: Adding and Renaming Worksheets, Modifying Worksheets,
3.2 Moving Through Cells, Adding Rows, Columns, and Cells, Resizing Rows and Columns,Selecting Cells, Moving and Copying Cells
3.3 Formulas and Functions: Formulas, Linking Worksheets, Basic Functions, AutoSum,Sorting and Filtering: Basic Sorts, Complex Sorts, Auto-fill, Deleting Rows, Columns,and Cells
3.4 Charting: Chart Types, drawing charts, Ranges, formatting charts

Unit 4: Office Automation- Presentation Techniques and slide shows (06 Hrs)

4.1 Create a new presentation, AutoContent Wizard, Design Template, Blank Presentation,Open an Existing Presentation, PowerPoint screen, Screen Layout
4.2 4.2 Working with slides: Insert a new slide, Notes, Slide layout, Apply a design template,Reorder Slides, Hide Slides, Hide Slide text, Add content, resize a placeholder or textbox, Move a placeholder or text box, Delete a placeholder or text box, Placeholder orText box properties, Bulleted and numbered lists, Adding notes
4.3 Work with text: Add text and edit options, Format text, Copy text formatting, Replacefonts, Line spacing, Change case, Spelling check, Spelling options
4.4 Working with tables: Adding a table, Entering text, Deleting a table, Changing rowwidth, Adding a row/column, Deleting a row/column, Combining cells ,Splitting a cell,Adding color to cells, To align text vertically in cells, To change table borders,Graphics, Add clip art, Add an image from a file, Save & Print, slide shows, slideanimation/transitions.

Unit 5: Internet& Applications: (04 Hrs)

5.1 Computer Network Types: LAN, PAN, MAN, CAN, WAN, Defining and describing theInternet, Brief history, Browsing the Web, Hypertext and hyperlinks, browsers,Uniform resource locator
5.2 Internet Resources: Email, Parts of email,
5.3 Protecting the computer: Password protection, Viruses, Virus protection software,Updating the software, Scanning files, Net banking precautions.
5.4 Social Networking: Features, Social impact, emerging trends, issues, Social Networking sites: Facebook, Twitter, linkedin, orkut, online booking services
5.5 Online Resources: Wikipedia, Blog, Job portals, C.V. writing
5.6 e-learning: e-Books, e-Magazines, e-News papers, OCW(open course wares): Sakshat(NPTEL) portal, MIT courseware

Unit 6: Cloud Computing Basics (03 Hrs)

6.1 Introduction to cloud computing
6.2 Cloud computing models: SAS, AAS, PAS
6.3 Examples of SAS, AAS, PAS (DropBox, Google Drive, Google Docs, Office 365 Prezi, etc.)

References:

1. TCI, "Introduction to Computers and Application Software", Publisher: Jones &BartlettLearning, 2010, ISBN: 1449609821, 9781449609825
2. Laura Story, Dawna Walls, "Microsoft Office 2010 Fundamentals", Publisher: CengageLearning, 2010, ISBN: 0538472464, 9780538472463
3. June Jamrich Parsons, Dan Oja, "Computer Concepts Illustrated series", Edition 5,Publisher Course Technology, 2005, ISBN 0619273550, 9780619273552
4. Cloud computing online resources

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
AC301(A).1	Identify their lacunas about some computer skills and try to overcome the same.	2
AC301(A).2	Practice the learned computer skills in real life and do their jobs more effectively.	3

AC-301(B): CYBER SECURITY

Course objectives:

1) To make students aware of different daily useful cyber security skills/rules

Unit 1: Networking Concepts Overview (03 Hrs)

Basics of Communication Systems, Transmission Media, ISO/OSI and TCP/IP models, Network types: Local Area Networks, Wide Area Networks, Internetworking, Packet Formats, Wireless Networks: Wireless concepts, Advantages of Wireless, Wireless network architecture, Reasons to use wireless, Internet.

Unit 2: Security Concepts(07 Hrs)

Information Security Overview, Information Security Services, Types of Attacks, Goals for Security, E-commerce Security, Computer Forensics, Steganography.

Importance of Physical Security, Biometric security & its types, Risk associated with improper physical access, Physical Security equipments.

Passwords: Define passwords, Types of passwords, Passwords Storage – Windows & Linux.

Unit 3: Security Threats and vulnerabilities(07Hrs)

Overview of Security threats, Hacking Techniques, Password Cracking, Types of password attacks, Insecure Network connections, Wi-Fi attacks & countermeasures, Information Warfare and Surveillance.

Cyber crime: e-mail related cyber crimes, Social network related cyber crimes, Desktop related cyber crimes, Social Engineering related cyber crimes, Network related cyber crimes, Cyber terrorism, Banking crimes,

Unit 4: Cryptography(05 Hrs)

Understanding cryptography, Goals of cryptography, Types of cryptography, Applications of Cryptography, Use of Hash function in cryptography, Digital signature in cryptography, Public Key infrastructure,

Unit 5: System &Network Security(03 Hrs)

System Security: Desktop Security, email security: PGP and SMIME, Web Security: web authentication, Security certificates, SSL and SET, Network Security: Overview of IDS, Intrusion Detection Systems and Intrusion Prevention Systems, Overview of Firewalls, Types of Firewalls, VPN Security, Security in Multimedia Networks, Fax Security.

Unit 6: OS Security (02 Hrs)

OS Security Vulnerabilities updates and patches, OS integrity checks, Anti-virus software, Design of secure OS and OS hardening, configuring the OS for security, Trusted OS.

Unit 7: Security Laws and Standards(03 Hrs)

Security laws genesis, International Scenario, Security Audit, IT Act 2000 and its amendments.

References:

1. Skills Factory, Certificate in Cyber Security, Text Book Special edition, Specially published for KBC NMU, Jalgaon
2. BPB Publication, “Fundamentals of Cyber Security”, MayankBhushan, Rajkumar Singh Rathore , AatifJamshed
3. CreateSpace Independent Publishing Platform, “Cyber Security Basics”, Don Franke, ISBN-13: 978-1522952190ISBN-10: 1522952195
4. Online references

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
AC301(B).1	Practice learned cyber security skills/rules in real life	3
AC301(B).1	Provide guidance about cyber security skills/rules to their friends, parents and relatives.	3

AC -301(C): INTRODUCTION TO LATEX

Course objectives:

The objectives of this course are

1) to introduce the student's basics, of typesetting, document formatting, table of content, cross referencing etc.
2) to prepare documents in Latex format, use of different command for formatting and making bibliography, cross referencing etc.
3) to prepare students for scientific writing such as books of Mathematics using mathematical typesetting, mathematical functions and various mathematical packages such as amsthm, mathlib etc.

Unit I: The Basics: Simple typesetting, Fonts, Type size, The Document, Document class, Page style, Page numbering, Formatting lengths, Parts of a document, Dividing the document . Table of contents, Index and Glossary: Table of contents, Index, Glossary, Displayed Text, borrowed words, Poetry in typesetting, making lists, Rows and Columns, Keeping tabs, Tables.

Unit II: Typesetting Mathematics: The basics, Custom commands, More on mathematics, Mathematics miscellany, New operators, The many faces of mathematics, Symbols. Typesetting Theorems: Theorems in L ATEX, Designer theorems—The amsthm package, Housekeeping. Several Kinds of Boxes: LR boxes, Paragraph boxes, Paragraph boxes with specific height, Nested boxes, Rule boxes.

Unit III: Floats: The figure environment, The table environment. Cross References in LATEX: Pointing to a page—the package varioref, Pointing outside—the package,. Footnotes, Margin pars, and Endnotes: Footnotes, Marginal notes, Endnotes.

Recommended Text Books:

[1] Latex Tutorials — A Primer, E. Krishnan and G. S. Krishna, 2003 Indian TEX Users Group Floor III, SJP Buildings, Cotton Hills Trivandrum 695014, India.

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
AC301(C).1	Write documents in required formats by various scientific journals and publisherstypeset mathematical books and research papers.	3
AC301(C).2	Test various mathematical and graphical packages for batter representation of their research outputs and solution of problem.	5

AC-301(D): HISTORY OF MATHEMATICS

Course objectives:

The objectives of this course are
1) to introduce historical background behind developments of mathematical inventions
2) to give glimpse of different schools of past historical periods
3) to motivate the students from ancient thinking in mathematics

Unit I: Egyptian and Phoenician Mathematics, The Ionian and Pythagorean Schools. Circ. 600 b.c.–400, The Schools of Athens and Cyzicus. Circ. 420–300 b.c., The First Alexandrian School. Circ. 300–30 b.c., The Second Alexandrian School. 30 b.c.–641 a.d.

Unit II: The Byzantine School. 641–1453, Systems of Numeration and Primitive Arithmetic, The Rise of Learning In Western Europe. Circ. 600–1200, The Mathematics of The Arabs, Introduction of Arabian Works into Europe. Circ. 1150–1450, The Development of Arithmetic. Circ. 1300–1637, The Mathematics of the Renaissance. Circ. 1450–1637, The Close of the Renaissance. Circ. 1586–1637.

Unit III: The History of Modern Mathematics, History of Mathematics from Descartes to Huygens. Circ. 1635–1675, The Life and Works of Newton, Leibnitz and the Mathematicians of the First Half of the Eighteenth Century, Lagrange, Laplace, and their Contemporaries. Circ. 1740–1830, Mathematics of the Nineteenth Century, Histry of Indian Mathematics and Mathematicians.

Recommended Textbook:

[1] A Short Account of The History of Mathematics By W. W. Rouse Ball , Dover Publications, Inc. New York, 1960

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
AC301(D).1	Study mathematical developments in Ionian and Pythagorean schools, schools of Athens and Cyzicus, first and second Alexandrian Schools etc.	1
AC301(D).2	Recite developments of systems of numeration and Primitive Arithmetic, Learning in Western Europe, the Arabs., the Development of Arithmetic. mathematics of the Renaissance.	1
AC301(D).3	To understand history of modern mathematics and the work of popular mathematicians from Descartes to Huygens, the Life and works of Newton, Leibnitz, Lagrange, Laplace, Format, Euler, Hilbert etc and the history of Indian Mathematics and Mathematicians.	2

MT-401: ANALYTIC NUMBER THEORY

Course objectives:

The objectives of this course are

1) to introduce the concept of arithmetic's, congruence's, arithmetical functions and their applications
2) to make aware about quadratic laws of reciprocity, Legendre and Jacobi symbols and their applications
3) to explain modular arithmetic, primitive roots, existence of primitive roots, their relation with quadratic reciprocity and calculus of indices.

Unit I: The fundamental theorem of arithmetic:

Divisibility, Greatest common divisor, Prime numbers, The fundamental theorem of arithmetic, The Euclidean algorithm, The gcd of more than two elements.

[8 Lectures]

Unit II: Arithmetic functions and Dirichlet multiplication:

The Mobious function $\mu(n)$, The Euler totient function $\phi(n)$, A relation connecting μ, ϕ, A product $\phi(n)$, Dirichlet product of arithmetic functions, Dirichlet inversion and Mobious inversion formula, The Mangoldt function $\Lambda(n)$, Multiplicative functions and Dirichlet multiplication, The inverse of completely multiplicative function, Liouville function, The divisor function, Generalized convolution.

[15 Lectures]

Unit III: Congruences:

Definition and basic properties of congruences, Residue classes and complete residue system, Linearcongruences, Reduced residue system and Euler-Fermat theorem, Polynomial congruences modulo p, Lagrange theorem, Application of Lagrange's theorem: Simultaneous linear equations, The Chinese remainder theorem and its applications, Polynomial congruences and prime power modulli. [15 Lectures]

Unit IV: Quadratic residues and Quadratic reciprocity law:

Quadratic residue, Legendre's symbol and its properties, Evaluation of $\left(-\frac{1}{P}\right)$ and $(\frac{2}{P})$, Gauss lemma, The quadratic reciprocity law, Application of reciprocity law, The Jacobi symbol. [**10 Lectures**]

Unit V:Primitive roots:

The exponent of a number modulo m, Primitive roots, Primitive roots and reduced residue system, The non-existence of primitive roots and mod 2^{α} for $\alpha \geq 3$, The existence of primitive roots mod p, The non-existence of primitive roots mod m, The primitive roots and quadratic residues, The index calculus . [**12 Lectures**]

Recommended Text Book:

[1] T. M. Apostol, Introduction to Analytic Number Theory, Narosa Publishing House (1980).

Reference Books:

[1] Ivan Niven and H. S. Zuckerman, An Introduction to the Theory of Numbers, Wiley East (2001).

[2] D.M. Burton, Elementary Number Theory, Tata McGraw Hill Education Private Limited (2009).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT401.1	Explain divisibility and its properties, use of divisibility to calculate gcd of numbers and prove fundamental theorem of arithmetic's. Also, to understand various arithmetical functions and their relationships.	2
MT401.2	Examine properties of congruence's and their use in finding residue and complete systems. Also, use them to prove Euler-Fermat, format Last theorems, Lagrange's theorem, Chinese remainder theorem	3
MT401.3	Illustrate properties of Legendre and Jacobi symbols and their use in reciprocity laws, existence of primitive roots for mod $2^{\alpha}$for $\alpha \geq 3$.	4

MT-402: TRANSFORM THEORY

Course objectives:

The objectives of this course are

1) To introduce the concept of Laplace and inverse Laplace transform, Fourier transform, Hankel transform, Mellin Transform and Z-transform.
2) To understand the properties and applications of these transform.
3) To use the basic knowledge to solve ordinary and partial differential equations with different forms of initial and boundary conditions. Also, some special type of integral equations.

Unit I: Laplace Transform:

Properties of Laplace Transform, Laplace Transform of the derivatives of function, Inverse Laplace transform, Properties of inverse Laplace transform, Inverse Laplace transform of derivatives, Convolution theorem, Heaviside's expansion theorem. Application of Laplace Transform, Solution of ODEs and PDEs. [**14 Lectures**]

Unit II: Fourier Integrals & Fourier Transforms:

Fourier integral theorem, Fourier transform Pairs, Properties of Fourier transform, Fourier cosine transform, Inverse Fourier Transform, Inverse Fourier sine Transform, Inverse Fourier cosine Transform, Properties of Fourier Transforms, Modulation theorem, Convolution theorem, Fourier Transform of the derivatives of functions, Parseval's identity, Application of Fourier Transforms to the solution of initial and boundary value problems. [**14 Lectures**]

Unit III: Mellin Transform:

Evaluation of Mellin transforms, Complex variable method and Applications. [**10 Lectures**]

Unit IV: The Henkel Transforms:

Evaluation of Henkel transforms, Applications of transform. [**10 lectures**]

Unit V: Finite Transforms:

Finite Fourier transform, Z- transform, Solutions of difference equations using Z-Transform. [**12 Lectures**]

Recommended Textbook:

[1] Larry Andrews, Bhimsen Shivamoggi, Integral Transforms for Engineers, Prentice Hall of India, New Delhi, 2005.

Reference Books:

[1] I. N. Sneddon, Fourier Transforms, McGraw Hill, 1951.
[2] Bracemell, Fourier Transforms and Its Applications, McGraw-Hill, 3rd Edition, 1999.

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT402.1	Apply the knowledge of integral transform to solve complex problems.	3
MT402.2	Evaluate problems of ordinary and partial differential equations with techniques of Integral transform.	3
MT402.3	Solve research problems of signal processing, data analysis and processing, image processing, in scientific simulation algorithms etc.	6

MT-403 (A): ADVANCED FUNCTIONAL ANALYSIS

Course objectives:

The objectives of this course are

1) To introduce the topological vector spaces, separation, properties, linear mappings, finite-dimensional spaces, metrization, boundedness and continuity.
2) To acquaint the Banach-Steinhaus theorem, the open Mapping theorem, the closed graph theorem, bilinear mappings.
3) To learn adjoint, compact operators, complex homomorphisms, basic properties of spectra, symbolic calculus, the group of invertible elements, Lomonosov's invariant subspace theorem.

Unit I: Topological Vector Spaces

Topological Vector Spaces, Separation, Properties, Linear mappings, Finite-dimensional spaces, Metrization, Boundedness and continuity, Seminorms and local convexity, Quotient spaces. **{Chapter 1[1]}[12 Lectures]**

Unit II: Topological Vector Spaces

Completeness, Baire category, The Banach-Steinhaus theorem, The open Mapping theorem, The closed graph theorem, Bilinear mappings.**{Chapter 2[1]}[12 Lectures]**

Unit III: Convexity:

The Hahn-Banach theorems, Weak topologies, Compact convex sets, Vector-valued integration, Holomorphic functions. **{Chapter 3[1]} [12 Lectures]**

Unit IV: Duality in Banach Spaces:

The normed dual of a normed space, Adjoints, Compact operators.

{ Chapter 4[1]}[12 Lectures]

Unit V: Banach Algebras:

Complex homomorphisms, Basic properties of spectra, Symbolic calculus, The group of invertible elements, Lomonosov's invariant subspace theorem.

{Chapter 6[1]}[12 Lectures]

Recommended Textbook:

[1] W. Rudin, Functional Analysis, Tata McGraw-Hill, 2007.

Reference Book:

[1] A. P. Robertson, W. Robertson, Topological Vector Spaces, Cambridge Tracts in Mathematics 53, Cambridge University Press, 1980.

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT403(A).1	Infer the properties of linear mappings, analysis of basis of finite dimensional spaces and boundedness and continuity	4
MT403(A).2	Explain the Banach-Steinhaus theorem, the open Mapping theorem, the closed graph theorem, bilinear mappings	3
MT403(A).3	Write the proof of properties of adjoint, compact operators, complex homomorphisms, spectra, symbolic calculus	3

MT-403(B): LINEAR INTEGRAL EQUATIONS

Course objectives:

The objectives of this course are

1) The basic concepts of reduction method, Fredholm alternative, an approximate method, iterative scheme and Volterra integral equation
2) Present the concept of Green's functions and singular integral equations and application to the solution of ordinary differential equations;
3) Study of Hilbert-Schmidt theorem and some immediate consequences, and integral transform methods.

Unit I: Fredholm and Volterra Integral Equations

Regularity conditions, Special kinds of kernels, Eigen values and eigen functions, Convolution integral, Reduction to a system of algebraic equations, Fredholm alternative, An approximate method, Examples, Iterative scheme, Volterra integral equation, Some results about the Resolvent kernel, Examples. [**15 Lectures**]

Unit II: Classical Fredholm Theory

The method of solution of Fredholm, Fredholm's first theory, Examples. [**8 Lectures**]

Unit III: Applications to Ordinary Differential Equations

Initial value problems, Boundary value problems, Adjoint equation of second order linear equation and self-adjoint equation, Dirac delta function, Green's function approach, Green's function for N^{th} – order ordinary differential equation, Modified Green's function, Examples. [**12 Lectures**]

Unit IV: Integral Equations with Symmetric Kernels

Introduction, Fundamental properties of eigenvalues and eigenfunctions for symmetric kernels, Expansion in eigenfunctions and bilinear form, Hilbert-Schmidt theorem and some immediate consequences, Solution of a symmetric integral equation, Examples. [**15 Lectures**]

Unit V: Singular Integral Equations and Integral Transform Methods

Abel's equations, Inversion formula for singular integral equations, Laplace transform, Applications to Volterra integral and integrodifferential equations with convolution type kernels, Abel's integral equation, Fourier transform, Solution by Fourier transform method. [**10 Lectures**]

Recommended Textbook:

[1] R. P. Kanwal, Linear Integral Equations, Theory and Techniques, Academic Press (1971).

Reference Books:

[1] S. G. Mikhlin, Integral Equations, Pergamon Press, Oxford (1957).
[2] A. M. Wazwaz, A first Course in Integral Equations, World Scientific, (1997).
[3] J. A. Cochran, The Analysis of Linear Integral Equations, Mc-Graw Hill, (1972).
[4] L. G. Chambers, Integral Equations: A Short Course, International Textbook Co., (1976).
[5] M. A. Krasnow, Kislov and G. Hakaronke, Problems and Exercises in Integral Equations, Mir Publications (1971).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT403(B).1	Illustrate linear Volterra and Fredholm integral equations using appropriate methods	2
MT403(B).2	Establish the relationship between integral and differential equations and transform one type into another	3
MT403(B).3	Determine solutions of differential and integral equations by Fourier and Laplace transforms	3

MT-403(C): DIFFERENCE EQUATIONS

Course objectives:

The objectives of this course are

1) to introduce the application of sequences and series of numbers, approximate sum etc
2) to distinguish between linear and nonlinear difference equations,methods of solving first order linear difference equations, equations with variable coefficients, technique to reduce it nonlinear equations to linear difference equation
3) Recognize and solve the initial value problems for linear systems, the acquaint of stability of linear systems, phase plane analysis for linear systems, stability of nonlinear systems, chaotic behavior asymptotic analysis of sums, linear equations, nonlinear equations.

Unit I: Difference Calculus:

Introduction, the Difference Operator, Summation, Generating Functions and Approximate Summation. [**15 Lectures**]

Unit II: Linear Difference Equations:

First Order Equations, General Results for Linear Equations, Solving Linear Equations, Applications, Equations with Variable Coefficients, Nonlinear Equations that can Be Linearized, The z-Transform. [**15 Lectures**]

Unit III: Stability Theory:

Initial Value Problems for Linear Systems, Stability of Linear Systems, Phase Plane Analysis for Linear Systems, Fundamental Matrices and Floquet Theory, Stability of Nonlinear Systems, Chaotic Behavior. [**15 Lectures**]

Unit IV: Asymptotic Methods:

Introduction, Asymptotic Analysis of Sums, Linear Equations, Nonlinear Equations. [**15 Lectures**]

Recommended Text Books:

[1] Walter Kelley and Allan Peterson, Difference Equations, An Introduction with Applications, Academic Press (1991).

[2] Calvin Ahlbrant and Allan Peterson, Discrete Hamiltonian Systems, Difference Equations, Continued Fractions and Riccati Equations, Kluwer (1996).

Reference Book:

[1] Saber Elaydi, An Introduction to Difference Equations, Springer (1999).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT403(C).1	Solve linear and nonlinear difference equations by various methods	3
MT403(C).2	Discuss the initial value problems for linear systems, identify the stability of linear systems, to learn the phase plane analysis for linear systems and stability of nonlinear systems	2
MT403(C).3	Apply the theory of difference equation in different engineering problem. Also, to make discrete mathematical models	3
MT403(C).4	Judge the difference between the qualitative and quantitative behavior of solutions of the difference equations and the corresponding differential equations.	3

MT-403 (D): CRYPTOGRAPHY

Course objectives:

The objectives of this course are

1) to introduce basics of cryptography, finite fields and their applications in cryptography, symmetric and asymmetric ciphers.
2) to make aware the students about public and private key, various algorithms of cryptosystems.
3) to introduction of RSA public key cryptosystem, Pollard's $p-1$ factorization algorithm,the index calculus and discrete logarithms, Quadratic residues and quadratic reciprocity, Probabilistic encryption

Unit I: An Introduction to Cryptography:

Simple substitution ciphers, Divisibility and greatest common divisors, Modular arithmetic, Prime numbers, unique factorization, and finite fields, Powers and primitive roots in finite fields, Cryptography before the computer age, Symmetric and asymmetric ciphers. **{Chapter 1 [1], 1.1. to 1.7}** [**15 Lectures**]

Unit II: Discrete Logarithms and Diffie–Hellman:

The birth of public key cryptography, The discrete logarithm problem, Diffie–Hellman key exchange, The ElGamal public key cryptosystem. The discrete logarithm problem, A collision algorithm for the DLP, The Chinese remainder theorem, The Pohlig–Hellman algorithm. **{Chapter 2[1], 1.1. to 1.7}** [**15 Lectures**]

Unit III: Integer Factorization and RSA:

Euler's formula and roots modulo pq , The RSA public key cryptosystem, Implementation and security issues, Primality testing, Pollard's $p-1$ factorization algorithm, Factorization via difference of squares, Smooth numbers and sieves, The index calculus and discrete logarithms, Quadratic residues and quadratic reciprocity, Probabilistic encryption. **{Chapter 3[1], 3.1. to 3.10}** [**15 Lectures**]

Unit IV: Elliptic Curves and Cryptography:

Elliptic curves, Elliptic curves over finite fields, The elliptic curve discrete logarithm problem, Elliptic curve cryptography, The evolution of public key cryptography, Lenstra's elliptic curve factorization algorithm. **{Ch. 5[1], 5.1.to 5.6}**[**15 Lectures**]

Recommended Book:

[1] Jeffrey Hoffstein, Jill Pipher, Joseph H. Silverman, An Introduction to Mathematical Cryptography, Springer Science & Business Media, LLC, 2008.

Reference Books:

[1] Jonathan Katz and Yehuda Lindell, Introduction to ModernCryptography, CRC Press.
[2] Hans Delfs, Helmut Knebl, Introduction to Cryptography, Principles and Applications, Springer Verlag.

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT403(D).1	Discuss Modular arithmetic, finite fields, Powers and primitive roots in finite fields, Symmetric and asymmetric ciphers.	2
MT403(D).2	Explain concepts of Diffie–Hellman cryptosystem, The ElGamal cryptosystem, a collision algorithm for the DLP and The Pohlig–Hellman algorithm.	3
MT403(D).3	Evaluate RSA public key cryptosystem, Pollard's $p-1$ factorization algorithm, the index calculus and discrete logarithms, Probabilistic encryption, Elliptic curves over finite fields, Elliptic curve cryptography, Lenstra's elliptic curve factorization algorithm.	5

MT-403(E): FRACTIONAL CALCULUS

Course objectives:

The objectives of this course are

1) Explain briefly the historical development of the fractional calculus from the time of Euler to the present and define the Riemann-Liouville fractional integral and evaluate fractional integrals of some common functions.
2) Focus on special Functions of the Fractional Calculus: Gamma Function, Mittag-Leffler Function, Wright Function, Beta function and their properties.
3) introduction of fractional differential and integral operators Riemann–Liouville integrals, Riemann–Liouville Derivatives,
4) Discuss various methods for the solutions to fractional differential equations.

Unit I: Special Functions of the Fractional Calculus

Brief review of Special Functions of the Fractional Calculus: Gamma Function, Mittag-Leffler Function, Wright Function, Gamma function, Properties of Gamma function, Limit representation of the Gamma function, Beta function, Mittag-Leffler Function, Derivative of the Mittag-Leffler Function, Differential equations Mittag-LefflerFunction, Summation formulas, Integration of the Mittag-Leffler Function.

[**15 Lectures**]

Unit II: Fractional Differential and Integral Operators

Riemann–Liouville Integrals, Riemann–Liouville Derivatives, Relations Between Riemann–Liouville Integrals and Derivatives, Gr ü nwald–Letnikov Operators, Caputo's Approach, Nonclassical representations of Caputo Operators.

[**15 Lectures**]

Unit III: Existence and Uniqueness of solutions to Fractional Differential Equations

Linear Fractional Differential Equations, Fractional Differential Equation of a General Form, Existence and Uniqueness Theorem as a Method of Solution, Dependence of a Solution on Initial Conditions, Standard Fractional Differential Equations, Sequential Fractional Differential Equations, Fractional Green's Function, Definition and Some Properties, One-Term Equation, Two Term Equation, Three-Term Equation, Four-Term Equation, General Case: n-term Equation. **[20 Lectures]**

Unit IV: Various Methods for the Solutions to Fractional Differential Equations

The Laplace transform method, The Mellin transform method, Power series method, Babenko's symbolic calculus method, Method of orthogonal polynomials.

[**10 Lectures**]

Recommended Text Books:

[1] Igor Podlubny, Fractional Differential Equations. San Diego: Academic Press; (1999).
[2] Kai Diethelm, The Analysis of Fractional Differential Equations, Springer Heidelberg Dordrecht London, New York, (2010).

Reference Books:

[1] A. Kilbas, H. M. Srivastava and J.J. Trujillo, Theory and Applications of Fractional Differential Equations, Elsevier, Amsterdam, (2006).
[2] L. Debnath, D. Bhatta, Integral Transforms and Their Applications, CRC Press, (2010).
[3] Shantanu Das, Functional Fractional Calculus, Springer-Verlag Berlin Heidelberg, (2011).
[4] K. S. Miller, B. Ross, An Introduction to the Fractional Calculus, John Wiley, New York, (1993).
[5] K. B. Oldham, J. Spanier, The Fractional Calculus. Academic Press, New York, (1974).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT403(E).1	Express sound knowledge of Riemann-Liouville and Caputo fractional derivatives and find the fractional derivatives of some common functions.	2
MT403(E).2	Test sufficient conditions under which the fractional integrals and derivatives exist.	4
MT403(E).3	Solve linear fractional differential equations using the Laplace transform.	3
MT403(E).4	Define the fractional calculus to the real-world problems.	5

MT-404(A): FUZZY SETS AND APPLICATIONS

Course objectives:

The objectives of this course are

1) the introduce the concepts of fuzzy sets, algebra of fuzzy sets and extension principal.
2) to explain generalize notions of fuzzy union, intersection and fuzzy complementation and their properties.
3) explore applications of fuzzy relations, fuzzy arithmetic's, fuzzy equations and fuzzy logic.

Unit I: Fuzzy sets:

Fuzzy sets and their types, Basic concepts on fuzzy sets, Properties of α-cuts, Representation of fuzzy sets, Extension principle of fuzzy sets.

{Chapter 1[1] (1.3, 1.4) & Chapter 2[1] (2.1, 2.2, 2.3) }[12 Lectures]

Unit II: Operations on fuzzy sets:

Fuzzy complements, Fuzzy intersections: t-norms, Fuzzy unions: t-conorms.

{Chapter 3[1] (3.2, 3.3, 3.4) } [12 Lectures]

Unit III: Combination of operations:

Combination of operations, Aggregation operation.

{Chapter 3[1] (3.5, 3.6) }[12 Lectures]

Unit IV: Fuzzy arithmetic:

Fuzzy numbers, Arithmetic operations on intervals, Arithmetic operations on fuzzy numbers, Fuzzy equations. **{Chapter 4[1] (4.1,4.3,4.4, 4.6)}[12 Lectures]**

Unit V:Fuzzy relations:

Fuzzy relations, Binary relations, Fuzzy equivalence relations, Fuzzy compatibility relations, Sup-t Compositions of fuzzy relations, inf ω_t compositions of fuzzy relations. **{ Chapter 5[1] (5.1,5.3,5.4, 5.5, 5.6, 5.9,5.10) } [12 Lectures]**

Recommended Text Book:

[1] G. J. Klir and B. Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice-Hall India, New Delhi, (1997).

Reference Books:

[1] H. J. Zimmermann, Fuzzy Set Theory and Its Applications, Springer, (2001).
[2] Didier Dubois and Henri Prade, Fuzzy Sets and Systems: Theory and Applications, Academic Press, (1980).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT404(A).1	Express the properties of $\alpha-$cuts, first, second and third decomposition theorems, Extension principle of fuzzy sets.	2
MT404(A).1	Apply deMorgan's and distributive laws for combination of t-norm, t-conorm and fuzzy complements.	3
MT404(A).1	Evaluate sum, difference, product, maximum, minimum of fuzzy numbers and various composition of fuzzy relations.	5

MT-404(B): COMMUTATIVE ALGEBRA

Course objectives:

The objectives of this course are

1) The course develops the theory of commutative rings.
2) Students will learn about Noetherian, Artinian rings and modules, Hilbert basis theorem, integral extensions, primary decomposition, tensor products, and Dedekind domains.
3) The commutative rings are of fundamental significance since geometric and number theoretic ideas are described algebraically by commutative rings.

Unit I: Modules

Free modules, Projective modules, Tensor products, Flat modules.

{[1] Chapter-I, 1.1-1.4} [12 Lectures]

Unit II: Localization

Ideals, Local rings and localization. **{[1] Chapter-II, 2.1-2.3}[12 Lectures]**

Unit III: Noetherian Rings

Noetherian modules, Primary decomposition, Artinian modules.

{[1] Chapter-III, 3.1-3.3} [**12 Lectures**]

Unit IV: Integral Extensions

Integral elements, Integral extensions, integrally closed domains.

{[1] Chapter-III, 3.1-3.3} [**12 Lectures**]

Unit V: Dedekind Domains

Valuation rings, Discrete valuation rings, Dedekind domains.

{[1] Chapter-III, 3.1-3.3} [**12 Lectures**]

Recommended Text Book:

[1] N. S. Gopalkrishnan, Commutative Algebra, Oxonian Press, New Delhi (1984).

Reference Books:

[1] M. F. Atiyah and I. G. Macdonald, Introduction to Commutative Algebra, Addison-Wesley, Reading, MA (1969).
[2] H. Matsumura, Commutative Algebra, Benjamin, New York (1970).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT404(B).1	Memorize basic definitions, constructions like tensor product and localization the basic theory for Noetherian rings, proves Hilbert basis theorem and dimension theory of local rings.	1
MT404(B).2	Correlate algebraic theory which is used in other parts of mathematics and computer algebra.	4
MT404(B).3	Collaborate the usefulness of abstract theory development so that different parts of mathematics, like number theory and algebraic geometry, can be described in the same framework.	6

MT-404(C): WAVELET ANALYSIS

Course objectives:

The objectives of this course are

1) To learn about basic concepts of wavelet functions and wavelet transforms that are used in solving ordinary and partial differential equations, data compression, denoising, signal and image processing.
2) To expose the students to the basics of wavelet theory and to illustrate the use of wavelet processing for data compression and noise suppression.
3) Students will have an ideal about generalized frames and study discrete time frequency analysis.

UNIT I: Preliminaries

Linear Algebra, Hilbert's spaces, Fourier series, Fourier integral and signal processing. **{1[Chapter 1 (1.1-1.4)]}** [**12 Lectures**]

UNIT II: Windowed Fourier Transforms

Motivation and definition, Time Frequency localization, The reconstruction formula.

{1[chapter 2 (2.1-2.3)]} [**12 Lectures**]

UNIT III: Continuous Wavelet Transforms

Motivation & definition of the wavelet transforms, the construction formula, Frequency localization. **{1[chapter 3 (3.1-3.3)]}** [**12 Lectures**]

UNIT IV: Generalized frames

From resolution of unity to frames, Reconstruction formula and consistency condition, Recursive construction. **{1[chapter 4 (4.1, 4.2, 4.4)]}** [**12 Lectures**]

UNIT V: Discrete time frequency analysis

Shannon Sampling theorem, Sampling in the time frequency domain, Time sampling verses frequency sampling. **{1[chapter 5(5.1-5.3)]}**[**12 Lectures**]

Recommended Text Book:

[1] Gerald Kaiser, A friendly guide to wavelets, Birkhauser, 1994.

Reference Books

[1] Eugenio Hernandez, Guido Weiss: A first course on Wavelets, CRC Press 1996.
[2] C.K. Chui, An introduction to Wavelets, Academic Press, 1992.
[3] M.W. Wong, Wavelet transforms & localization operators, BerkhauserVerlag.

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT404(C).1	Recall wavelet basis and characterize continuous and discrete wavelet transforms.	1
MT404(C).1	Conclude the difference between windowed Fourier transform and wavelet transform.	4
MT404(C).1	Established multi resolution analysis and identify various wavelets and evaluate their time-frequency resolution properties	3

MT-404 (D): CONTROL THEORY

Course objectives:

The objectives of this course are

1) To expose the students to the basic concepts of observability, controllability Grammian, stability uniform stability, asymptotic stability of linear systems-Linear time varying systems, and Perturbed linear systems– Nonlinear systems
2) To provide adequate knowledge about the applications of adjoint systems and optimal control, Linear time invariant systems – Nonlinear Systems
3) Introduce the concept of stabilization via linear feedback control, Steering function and Reconstruction kernel.

Unit I: Observability

Linear Systems – Observability Grammian – Constant coefficient systems – Reconstruction kernel – Nonlinear Systems. [**10 Lectures**]

Unit-II: Controllability

Linear systems – Controllability Grammian – Adjoint systems – Constant coefficient systems –Steering function – Nonlinear systems. [**15 Lectures**]

Unit-III: Stability

Stability – Uniform stability – Asymptotic stability of linear systems - Linear time varying systems – Perturbed linear systems – Nonlinear systems. [**15 Lectures**]

Unit-IV: Stabilizability

Stabilization via linear feedback control – Bass method – Controllable subspace– Stabilization with restricted feedback. [**10 Lectures**]

Unit-V: Optimal Control

Linear time varying systems with quadratic performance criteria – Matrix Riccati equation – Linear time invariant systems – Nonlinear Systems. [**10 Lectures**]

Recommended Textbook:

[1] K. Balachandran and J.P. Dauer: Elements of Control Theory, Narosa Publishing House, New Delhi, 2nd Edition, (2012). (Unit-I : Chapter 2, Unit-II : Chapter 3: Sections: (3.1-3.3), Unit-III: Chapter 4, Unit-IV: Chapter 5, Unit-V : Chapter 6)

Reference Books:

[1] R. Conti: Linear Differential Equations and Control, Academic Press, London, (1976).
[2] R. F. Curtain and A.J. Pritchard: Functional Analysis and Modern Applied Mathematics, Academic Press, New York, (1977).
[3] J. Klamka: Controllability of Dynamical Systems, Kluwer Academic Publisher, Dordrecht, (1991).
[4] D. L. Russell, Mathematics of Finite Dimensional Control Systems, Marcel Dekker, New York, (1979).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT404(D).1	Compute the stability analysis nonlinear systems by Lyapunovmethoddevelop design skills in optimal control problems	3
MT404(D).2	Analyze the results and propose of observability grammian, controllability grammian, Uniform stability, Perturbed linear systems etc.	4

MT-404(E): FIXED POINT THEORY AND APPLICATIONS

Course objectives:

The objectives of this course are

1) To introduce the Banach contraction principle and its various generalization for non-expansive mappings, quasi-non-expansive mappings and densifying maps
2) To acquaint the multivalued mappings and its fixed points and use this technique in integral equations
3) To understand the methods of successive approximations to obtain the fixed points. Also, the study of the Mann iterative process and iterative methods for variational inequalities.

Unit 1. Introductory Concepts

Topological Preliminaries, Metric Spaces, Hilbert Spaces, Topological Vector Spaces, Locally Convex Spaces, Normal Structure. {[1], Ch. 1: 1.1, 1.2} [**10 Lectures**]

Unit 2. Fixed Point Theorems

Fixed Points, The Banach Contraction Principle, Fixed Point Theorems for Non-expansive Mappings, Quasi-nonexpansive Mappings and Fixed Points, Densifying Maps and Fixed Points {[1], Ch. 1: 1.3 to 1.7} [**20 Lectures**]

Unit 3. Fixed Points For Multivalued Mappings

Multi-valued Mappings and Fixed Points, Integral Equations {[1], Ch. 1: 1.8, 1.9}

[**15 Lectures**]

Unit 4. Successive Approximations

The Method of Successive Approximations, The Iteration Process for Continuous Functions, The Mann Iterative Process, The Sequence of Iterates of Non-expansive Mappings, Convergence Criteria in Convex Metric Spaces, Iterative Methods for Variational Inequalities. {[1], Ch. 1: 1.10, 1.11} **[15 Lectures]**

Recommended Text Book:

[1] Sankatha Singh, Bruce Watson and Pramila Srivastava, Fixed Point Theory and Best Approximation: The KKM-map Principle, Springer Science Business Media Dordrecht (1997), Originally published by Kluwer Academic Publishers in 1997.

Reference books:

[1] Vasile I. Istr ă tescu, Fixed Point Theory, An Introduction, D. Reidal Publishing Company, Holland, (2001).
[2] Mohamed A. Khamsi and William A. Kirk, An Introduction to Metric Spaces and Fixed Point Theory, Hohn Wiley and Sons, Inc, New York (2001).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT404(E).1	Write the prove the existence of fixed-point theorems of generalized Banach contraction mappings	3
MT404(E).2	Evaluate the fixed point of multi-valued mappings and apply this technique for solution of differential and integral equations	5
MT404(E).3	Examine fixed points for self-mappings using successive approximations and for monotone non-expansive mappings the Mann iterative process and iterative methods.	3

MT-405: OPERATIONS RESEARCH

Course objectives:

The objectives of this course are
1) to introduce the theory of convex sets, functions, formulation of LPP, techniques of integer and non-integer solution of Linear and nonlinear programming problems.
2) to introduce students to use quantitative methods and techniques for effective decisions–making;
3) to make model formulation and applications that are used in solving business decision problems.

Unit I: Convex Set and Functions

Convex set, Supporting and separating hyperplanes, Convex polyhedron and polytope, convex functions, Generalized convexity. {[1], Chap 2: 2.1 to 2.5}

[15 Lectures]

Unit II: Linear Programming Problems

Linear programming model, Graphical solution of some linear programs, Standard Linear Program and basic Solution, Simplex Algorithm and Simplex method, Charnes M-Technique, Applications, Dual Linear program, Simplex multipliers, Duality Theorems and Dual Simplex method. {Chap 3: 3.1 to 3.6, Chap 4: 4.1 to 4.3, 4.5}

[20 Lectures]

Unit III: Integer Programming Problems

Gomory's algorithm for pure integer linear programs, Branch and bound methods. {Chap 6, 6.4, 6.6} **[10 Lectures]**

Unit V: Game Theory

Game theory problem, Two-person zero sum game, Finite matrix game, Graphical method for $2\times n$ and $m\times 2$ matrix game, Some theorems, Dominance principle.

{Chap 16, 16.1 to 16.6} **[15 Lectures]**

Recommended Textbook:

[1]. N. S. Combo, Mathematical programming Techniques, Affiliated East-West Press PVT, New, Delhi, (1991).

Reference books:

[1]. H. A. Taha, Operations Research: An Introduction, Prentice Hall of India, (1997).
[2]. KantiSwarup, P. K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, new Delhi, (1991).

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT405.1	Describe mathematical tools needed to evaluate optimization problems.	2
MT405.2	Develop a report that describes the model and the solving technique.	2
MT405.3	Analyze the results and propose recommendations in language understandable to the decision-making processes in Management Engineering.	4

MT-406: PRACTICAL - IV

Course objectives:

The objectives of this course are

1) to introduce the students the basics of programming language Python.
2) To use different logic to formulate the Python code for variety of problems
3) To aquatint the Python programming for graphics.

List of Python Programs to be coved under this practical course

1. Write a program that computes and prints the result different Mathematical expressions and stars or any symbol with different types.

2. Ask the user to enter a number. Print out the square, cubes, square root and x, 2x, 3x, 4x, and 5x, each separated by three dashes etc of the number, but use the *sep* optional argument to print it out in a full sentence that ends in a period.
3. Write a program that asks the user for a weight in kilograms and converts it to pounds. There are 2.2 pounds in a kilogram.
4. Write a program that asks the user to enter three numbers (use three separate input statements).
5. Create variables called total and average that hold the sum and average of the three numbers and print out the values of total and average.
6. Write a program that prints your name 100 times.
7. Write a program that outputs 100 lines, numbered 1 to 100, each with your name on it. The output should look like as expected.
8. Write a program that prints out a list of the integers from 1 to 20 and their squares.
9. Write a program that uses a for loop to print the numbers 8, 11, 14, 17, 20, . . . , 83, 86, 89.
10. Write a program that uses a for loop to print the numbers 100, 98, 96, . . . , 4, 2.
11. Write a program that uses exactly four for loops to print the sequence of letters below.

    AAAAAAAAAABBBBBBBCDCDCDCDEFFFFFFG

12. The Fibonacci numbers are the sequence below, where the first two numbers are 1, and each number thereafter is the sum of the two preceding numbers. Write a program that asks the user how many Fibonacci numbers to print and then prints that many. 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89 . . .
13. Write a program that generates and prints 50 random integers, each between 3 and 6.
14. Write a program that asks the user to enter two numbers, x and y, and computes |x-y|/x+y
15. Write a program that asks the user for a number of seconds and prints out how many minutes and seconds that is. For instance, 200 seconds is 3 minutes and 20 seconds.
16. Write a program that asks the user for a number and prints out the factorial of that number.
17. Write a program that asks the user for a number and then prints out the sine, cosine, and tangent of that number.
18. Write a program that asks the user to enter an angle in degrees and prints out the sine of that angle.
19. A year is a leap year if it is divisible by 4, except that years divisible by 100 are not leap years unless they are also divisible by 400. Ask the user to enter a year, and, using the // operator, determine how many leap years there have been between 1600 and that year.
20. Write a program that asks the user to enter a length in centimeters. If the user enters a negative length, the program should tell the user that the entry is invalid. Otherwise, the program should convert the length to inches and print out the result. There are 2.54 centimeters in an inch.
21. Ask the user for a temperature. Then ask them what units, Celsius or Fahrenheit, the temperature is in. Your program should convert the temperature to the other unit. The conversions are $F = 9/5\ C + 32$ and $C = 5/9\ (F - 32)$.

22. A year is a leap year if it is divisible by 4, except that years divisible by 100 are not leap years unless they are also divisible by 400. Write a program that asks the user for a year and prints out whether it is a leap year or not.
23. Write a program that asks the user to enter a number and prints out all the divisors of that number. [Hint: the % operator is used to tell if a number is divisible by something].
24. Write a program that counts how many of the squares of the numbers from 1 to 100 end in a 1 as well as 9.
25. Write a program that asks the user to enter a value n, and then computes (1+ 1/2 + 1/3 +…+ 1/n)-ln(n). The ln function is log in the math module.
26. Write a program to compute the sum 1 -2 + 3 - 4 + _ _ _ + 1999 -2000.
27. People often forget closing parentheses when entering formulas. Write a program that asks the user to enter a formula and prints out whether the formula has the same number of opening and closing parentheses.
28. Write a program that asks the user to enter a word and prints out whether that word contains any vowels.
29. Write a program that asks the user to enter a list of integers. Do the following:
    (a) Print the total number of items in the list.
    (b) Print the last item in the list.
    (c) Print the list in reverse order.
    (d) Print Yes if the list contains a 5 and No otherwise.
30. The code below prints the numbers from 1 to 50. Rewrite the code using a while loop to accomplish the same thing. for i in range(1,51): print(i)
    (a) Write a program that uses a while loop (not a for loop) to read through a string and print the characters of the string one-by-one on separate lines.
    (b) Modify the program above to print out every second character of the string.
31. Write a program that asks the user for a weight and converts it from kilograms to pounds. Whenever the user enters a weight below 0, the program should tell them that their entry is invalid and then ask them again to enter a weight. [Hint: Use a while loop, not an if statement].
32. Write a function called first_diff that is given two strings and returns the first location in which the strings differ. If the strings are identical, it should return -1.
33. Write a function called binom that takes two integers n and k and returns the binomial coefficient (n,k). The definition is (n,k) = n!/k!(n-k)!
34. Write a function that takes an integer n and returns a random integer with exactly n digits. For instance, if n is 3, then 125 and 593 would be valid return values, but 093 would not because that is really 93, which is a two-digit number.
35. Write a function called number of factors that takes an integer and returns how many factors the number has.
36. Write a function called factors that takes an integer and returns a list of its factors.
37. Programming for graphics.

Recommended Text Book:

[1] Brian Heinold, A Practical Introduction to Python Programming, , 2012 (Licensed under a Creative Commons Attribution-Noncommercial-Share Alike 3.0 Unported License)

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
MT406.1	Write Python codes to obtain the solution of mathematical problems.	3
MT406.2	Argue Python programs for numerical and number theoretical problems to obtain precise solutions.	5
MT406.3	Device Python programs for graphics.	6

AC-401(A): HUMAN RIGHTS

Course objectives:

1) To make students aware about human rights and human values

Unit 1: Introduction to Human Rights

1.1 Concept of Human Rights
1.2 Nature and Scope of Human Rights
1.3 Fundamental Rights and Fundamental Duties
1.4 Interrelation of Rights and Duties

Unit 2: Human Rights in India

2.1: Meaning and Significance of :
1) Right to Equality 2) Right to Freedom, 3) Right against Exploitation, 4) Right to Freedom of Religion, 5) Cultural and Educational Rights, and
6) Right to Constitutional Remedies.
2.2 Constitutional Provisions for Human Rights
2.3 Declaration of Human Rights
2.4: National Human Rights Commission

Unit 3: Human Values

3.1: Meaning and Definitions of Values
3.2: Importance of values in the life of Individual
3.3: Types of Values
3.4: Programmes for conservation of Values

Unit 4: Status of Social and Economically Disadvantaged people and their rights

4.1: Rights of women and children in the context of Social status
4.2: The Minorities and Human Rights
4.3: Status of SC/ST and other Indigenous People in the Indian Scenario
4.4: Human rights of economically disadvantaged Society

References:

1) Human rights education – YCMOU, Nasik
2) Value education – SCERT, Pune
3) Human rights reference handbook – Lucille whare

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
AC401(A).1	Practice the learned issues under human rights and human values in real life	3
AC401(A).1	Provide social justices to people around them andprovide guidance about human rights to their friends, parents and relatives	3

AC-401(B): CURRENT AFFAIRS

Course objectives:

1) To make students updated about current affairs of India and world.

Unit – IPolitics&Economy : National & International Political Activity, Organization. Economy & Business, Corporate world**(8 Lectures)**
Unit – IIAwards and recognitions: National & International Awards and recognitions Books and authors**(7 Lectures)**
Unit -IIIScience& Technology: Software, Automobile, Space Research
New inventions and discoveries**(7 Lectures)**
Unit – IVEnvironment& Sports: Summit & conference, Ecology & Climate, Organization. National & International Games, Olympics, commonwealth etc. **(8 Lectures)**

Suggested Course Reading (Use recent years 'data and current literature) :

1. India 2019, by Publications Division Government of India
2. Manorama Year Book by Philip Mathew,
3. India 2019, Rajiv Maharshi
4. Quick General Knowledge 2018 with Current Affairs Update, Disha Experts
5. General Knowledge 2018: Latest Who's Who & Current Affairs by RPH Editorial Board.

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
AC401(B).1	Identify important issues currently/ recently happening in India or world	1
AC401(B).2	Summarize current affairs regularly.	2

AC-401(C): REVIEW OF RESEARCH PAPERS

Course objectives:

The objectives of this course are
1) to make aware students about research papers and articles
2) to make aware students about recent trends of research in Mathematics
3) to make aware the students about research writing, ethics and thinking.

Review of research papers on following fields:

- Algebra, Linear Algebra, Finite field Theory, Commutative Algebra, Graph theory, Number Theory
- Analysis, Complex Analysis, Numerical Analysis, Fixed point theory, Functional Analysis, Topology, Lie Algebra
- Differential and Integral Equations, Fractional Differential Equations, Integral and Transform Theory
- Fuzzy Mathematics, Fuzzy Logic
- Coding theory, Cryptography
- Fluid Dynamics, Classical Mechanics, Computational Fluid Mechanics

Review of research papers is not only limited to above field, but may also include any other filed related to Mathematics

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
AC401(C).1	Develop mathematical knowledge to analyze research problems	6
AC401(C).2	Criticize mathematical proofs devised in the research papers	5
AC401(C).3	Write mathematical research articles, reviews and documents.	6

AC-401(D): VEDIC MATHEMATICS

Course objectives:

The objectives of this course are
1) to introduce various Vedic methods of solving problems
2) to make aware about historical background of mathematical formula and methods
3) ancient derivations of calculus, differentiations, number theoretic problems reported in various granthas.

Unit I: Actual Applications of the Vedic Sutras, Arithmetical Computations, Multiplication, Practical Application (compound multiplication), Practice and Proportion, Division by the Nikhilam method, Division by the Parevartpa method, Argumental Division, Factorization (of simple quadratics), Factorization (of harder quadratics), Factorization of Cubics etc., Highest Common Factor.

Unit II: Simple Equations (First Principles), Simple Equations (by Sunyam etc.), Merger Type of Easy Simple Equations, Extension method, Complex Mergers, Simultaneous Simple Equations, Miscellaneous (Simple) Equations, Quadratic Equations, Cubic Equations, Bi-quadratic Equations, Multiple Simultaneous Equations, Simultaneous Quadratic Equations.

Unit III: Factorization & Differential Calculus, Partial Fractions, Integration by Partial Fractions, The Vedic Numerical Code, Recurring Decimals, Straight Division, Auxiliary Fractions, Divisibility & Simple Osculators, Divisibility & Complex Multiplex Osculators, Sum & Difference of Squares, Elementary Squaring, Cubing etc. Straight Squaring, Vargamula (square root), Cube Roots of Exact Cubes, Cube Roots (General), Pythagoras Theorem etc., Apollonius' Theorem, Analytical Conics.

Recommended Text Books:

[1] Vedic Mathematics, JagadguruShankaracharya, Sri BharatiKrisnaTirtha Maharaja (edited by Dr. V. S. Agrawala), MotilalBanaridas, Delhi, 1981

Course outcomes:

After completing this course, the students will able to

Course Outcome	Course Outcome	Cognitive Level
AC401(D).1	Classify Vedic Sutras, Arithmetical Computations, Practice and Proportion, Nikhilam and Parevartpa methods of Division.	2
AC401(D).2	Determine methods for solution of Simple Equations, Merger Type Equations, Simultaneous Simple Equations, Quadratic Equations, Cubic Equations, Bi-quadratic Equations and Simultaneous Quadratic Equations.	3
AC401(D).3	Explain the ancient work on factorization, Differential Calculus, Partial Fractions, Integration by Partial Fractions, Divisibility & Simple Osculators, Divisibility & Complex Multiplex, Vargamula, Cube Roots of Exact Cubes and Analytical Conics.	4