| Session: 2023-24(Scheme), 2025-26(Syllabus) | |
|---|---|
| **Part A – Introduction** | |
| Subject | Mathematics |
| Semester | V |
| Name of the Course | Sequences and Series |
| Course Code | B23-MAT-501 |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | CC/MCC |
| Level of the course | 300-399 |
| Pre-requisite for the course (ifany) | |
| CourseLearningOutcomes(CLO): | **After completing this course, the learner will be able to**:<br>1. Understand basic concepts of real number system, set theory and preliminary results on neighbourhood of a point, interior and limit points, open sets, closed sets etc.<br>2. Learn about denumerability of subsets of real numbers, sequences, their limits, boundedness and convergence. Determine the convergence and divergence of a sequence. Understand Cauchy sequence and Cauchy general principle of convergence of sequence.<br>3. Attain skills to determine convergence of a series of real numbers by applying various tests.<br>4. To know absolute and conditional convergence of alternating series and apply theory to check the convergence of arbitrary series. |
| CLO 5 is related to the practical component of the course. | 5*Attain cognitive and technical skill required to check the convergence of sequences and infinite series and verify the same by applying various available tests and tools. |

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| Credits | Theory | Practical | Total |
|---|---|---|---|
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| Internal Assessment Marks | 20 | 10 | 30 |
| End Term Examination Marks | 50 | 20 | 70 |
| Examination Time | 3 Hours | 3 Hours | |

Max. Marks:100

**PartB-Contentsofthe Course**

**Instructions for Paper- Setter**

**Note:** The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Boundedness of the set of real numbers, Least upper bound and Greatest lower bound of a set. Archimedean, algebraic and ordered properties in □. The real number system as a complete ordered field. Neighbourhoods, interior points, isolated points, limit points, Open sets, closed sets, interior of a set, closure of a set in real numbers and their properties. Bolzano-Weierstrass theorem. Open covers, compact sets and Heine-Borel theorem. | 12 |
| II | Denumerable and non-denumerable sets, Denumerability of integers, rationals and non-denumerability of real numbers. Sequences: Real sequences and their convergence, Theorems on limit of sequence, Bounded and monotonic sequences, Cauchy's sequence, Cauchy general principle of convergence, Subsequences and subsequential limits, Limit superior and limit inferior. | 12 |
| III | Infinite series: Convergence and divergence of Infinite Series, Comparison tests of positive terms infinite series, Cauchy's general principle of Convergence of series, Convergence and divergence of geometric series, Hyper Harmonic series or p-series, D-Alembert's ratio test, Raabe's test, Logarithmic test, Cauchy's nth root test, De-Morgan and Bertrand's test, Gauss | 12 |

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|---|---|---|
| | Test, Cauchy's integral test, Cauchy's condensation test. | |
| IV | Alternating series, Absolute and conditional convergence, Leibnitz test.<br>Arbitrary series, Abel's and Dirichlet's test, Insertion and removal of parenthesis, Re-arrangement of terms in a series, Riemann's re-arrangement theorem and Pringsheim's theorem (statement only). Cauchy product of series (definitions and examples only). | 12 |
| | **Practical** | |
| | The practical component of the course has two parts, Problem Solving and Practical's using Mathematica/ Matlab/Maple/Scilab/ Maxima etc. software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.<br>**(A) Problem Solving-** Questions related to the following problems will be solved and their record will be maintained in the Practical Notebook:<br>1. Problem demonstrating that the set of rational numbers is not order complete.<br>2. Practical problems on finding lub and glb of a set.<br>3. Problem solving to find limit point of a set using Bolzano Weierstrass Theorem.<br>4. Problems solving using monotone convergence theorem.<br>5. Practical problems demonstrating the use of Cauchy's first | 30 |

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and second theorems for convergence of sequences.

6. Problem solving on limit inferior and limit superior of a sequence.
7. Practical problems on convergence/divergence of positive term series demonstrating the application of various convergence tests.
8. Problem solving on
   (a) conditional convergence and
   (b) absolute convergence of an alternating series.
9. Practical problems to demonstrate
10. Cauchy product of two convergent series need not be convergent.
11. Cauchy product of two divergent series need not be divergent.
12. Practical problems demonstrating the denumerability of the cartesian product of denumerable sets.
13. Demonstrate the non-denumerability of the set of irrationals.

**(B) The following practicals will be done using Mathematica/ Matlab/Maple/Scilab/ Maxima etc.software and also verify results by applying various convergence tests. Their record will be maintained in the practical note book:**

1. Testing the convergence of infinite series of positive terms by the use of sequence of partial sums.
2. Testing the convergence of an infinite positive term series.
3. Testing the absolute convergence of an alternating series and comment about conditional convergence.
4. Practical problems on the convergence of series with arbitrary terms.
5. Testing the convergence/divergence/oscillation behavior of sequences of real numbers.
6. Determine the lub and glb of the subset of real numbers and observe whether they belong to the set or not.

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| Suggested Evaluation Methods | |
|---|---|
| **InternalAssessment:**<br>➢ **Theory 20**<br>• Class Participation: 5<br>• Seminar/presentation/assignment/quiz/class test etc.: 5<br>• Mid-Term Exam: 10<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.: 10<br>• Mid-Term Exam: | **End Term Examination:**<br>➢ **Theory 50**<br>Written Examination<br>➢ **Practicum 20**<br>Lab record, viva-voce, write up and execution of the program |

**PartC-Learning Resources**

**Recommended Books:**


1. T. M. Apostol (2008). *Mathematical Analysis: A Modern Approach to Advanced Calculus*. Pearson Education.
2. Charalambos D. Aliprantis& Owen Burkinshaw( 1998). *Principles of Real Analysis* (3rd edition). Academic Pres.
3. Robert G. Bartle & Donald R. Sherbert (2015). *Introduction to Real Analysis* (4th edition).Wiley India.
4. Gerald G. Bilodeau, Paul R. Thie& G. E. Keough (2015). *An Introduction to Analysis* (2nd edition), Jones and Bartlett India Pvt. Ltd.
5. E. Hewitt & K. Stromberg (2013). *Real and Abstract Analysis*. Springer-Verlag.
6. K. A. Ross (2013). *Elementary Analysis*: *The Theory of Calculus* (2nd edition). Springer.
7. Walter Rudin. *Principles of Mathematical Analysis* (3rd edition), Tata McGraw Hill.
8. R. R. Goldberg (1970). *Real Analysis*. Oxford & I. B. H. Publishing Co., New Delhi.
9 Shanti Narayan & P. K. Mittal (2005). *A Course in Mathematical Analysis* . S. Chand and company, New Delhi.
10. S. C. Malik & S. Arora (2021) . *Mathematical Analysis*. Wiley Eastern Ltd., Allahabad.


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MCC-10 Mechanics-I

| Session: 2023-24 (Scheme), 2025-26 (Syllabus) | |
|---|---|
| **PartA - Introduction** | |
| Subject | Mathematics |
| Semester | V |
| Name of the Course | Mechanics-I |
| Course Code | B23-MAT-502 |
| CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | MCC |
| Level of the course | 300-399 |
| Pre-requisite for the course (ifany) | Mathematics as a subject at level 5.0 |
| CourseLearningOutcomes(CLO): | After completing this course, the learner will be able to:<br>1. Comprehensive, factual and theoretical knowledge of the basic concepts of forces, their resultant, moments and couples and to attain the problem solving skill for scientific problems.<br>2. Have deeper knowledge and understanding of the concepts of friction and laws of friction, centre of mass and centre of gravity and to solve problems related to these concepts.<br>3. Gain knowledge of concepts of dynamics like velocity, acceleration and angular velocity, simple harmonic motion and to develop the skill of solving simple dynamical problems within the chosen fields of learning.<br>4. Understand and learn the problems based on concepts of Newton's laws of motion, work, power, energy and apply them to solve related problems in real life. |

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| CLO 5 is related to the practical component of the course. | 5.Toattain cognitive and technical skills required for solving practical problems and case studies related to forces, couples, moments, velocity, acceleration, simple harmonic motion, Newton's laws of motion, power and energy. Have hands on skill to create simple program in MATLAB/SCILAB or other softwares to calculate resultant of forces, acceleration, velocity, coefficient of friction, angle of friction, work done, energy and power. | | |
| Credits | Theory | Practical | Total |
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| Internal Assessment Marks | 20 | 10 | 30 |
| End term Examination Marks | 50 | 20 | 70 |
| Examination Time | 3 Hours | 3 Hours | |

**Max. Marks:100**

**PartB-Contentsofthe Course**

**Instructions for Paper- Setter**

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Composition and resolution of forces, Parallel forces, Moment of force about a point and a line, Couple, Moment of couple about a point and a line. | 12 |
| II | Concept of friction, Laws of friction, Concepts of centre of mass and centre of gravity, Centre of gravity of a uniform arc, plane area and solids of revolution. | 12 |

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|---|---|---|
| III | Velocity and acceleration of a particle along a curve: radial and transverse components, tangential and normal components, Relative velocity, Angular velocity and acceleration, Simple harmonic motion, Elastic string. | 12 |
| IV | Newton's laws of motion, Work, Power and Energy. | 12 |
| | **Practical** | |
| | The practical component of the course has two parts, Problem Solving and Practical's using MATLAB/SCILAB software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.<br>**(A) Problem Solving- Questions related to the following problems will be worked out and record of those will be maintained in the Practical Notebook:**<br>1. Practical problems to find resultant and resolution of forces.<br>2. Practical problems based on Lami's theorem and its converse.<br>3. Practical problems on equilibrium of a number of concurrent forces.<br>4. Practical problems to find moment of couples. | 30 |

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| | 5. Practical problems on motion of a particle attached to an elastic string.<br>6. Practical problems on motion of two bodies connected by a string.<br>7. Practical problems based on principle of conservation of energy.<br>**(B) The following practical will be done using MATLAB/SCILAB or other softwares and record of those will be maintained in the practical note book:**<br>1. To find magnitude and resultant of given forces.<br>2. To find ratio of magnitude of forces using Lami's theorem.<br>3. To find coefficient of friction, resultant friction, angle of friction.<br>4. To find limits between which a force lie in order to keep a body in equilibrium on a rough inclined plane.<br>5. To find magnitude and direction of velocity, acceleration along a plane curve.<br>6. To find magnitude and direction of radial velocity, transverse velocity, radial acceleration, transverse acceleration along a plane curve.<br>7. To find magnitude and direction of tangential velocity, normal velocity, tangential acceleration, normal acceleration along a plane curve.<br>8. To find work done by a constant force, variable force and in stretching an elastic string.<br>9. To find rate of doing work (power).<br>10. To find kinetic energy and potential energy of a body. | |

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| Suggested Evaluation Methods | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory 20**<br>• Class Participation: 5<br>• Seminar/presentation/assignment/quiz/class test etc.: 5<br>• Mid-Term Exam: 10<br>➢ **Practicum 10**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.: 10<br>• Mid-Term Exam: | **End Term Examination:**<br>➢ **Theory 50**<br>Written Examination<br>➢ **Practical 20**<br>Lab record, viva-voce, write up and execution of the program |

## PartC-Learning Resources

**Recommended Books:**


1. Stephan J. Chapman (2020). *MATLAB Programming for Engineers* (6th edition). Cengage Learning.
2. William Palm Lii (2017). *A concise introduction to MATLAB* (2nd edition). Tata Mcgraw-Hill Education.
3. RudraPratap (2010). *Getting Started with MATLAB:A quick introduction for scientists and engineers*. Oxford University Press.
4. A. S. Ramsey (2009). *Statics*. Cambridge University Press.
5. A. S. Ramsey (2009). *Dynamics*. Cambridge University Press.
6. S.L. Loney (2006). *An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies*. Read Books.
7. A.P. Roberts (2003). *Statics and Dynamics with Background in Mathematics*. Cambridge University Press.
8. S.L. Loney (1995). *An Elementary Treatise on Statics*, Radha Publishing House.
9. P.L. Srivastava (1964). *Elementary Dynamics*. Ram NarainLal, Beni Prasad Publishers Allahabad.
10. R. S. Varma (1962). *A Text Book of Statics*. Pothishala Pvt. Ltd.
11. J. L. Synge & B. A. Griffith (1949). *Principles of Mechanics*. McGraw-Hill.


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DSE-2 Linear Programming

| Session: 2023-24 (Scheme), 2025-26 (Syllabus) | |
|---|---|
| **Part A – Introduction** | |
| Subject | Mathematics |
| Semester | V |
| Name of the Course | Linear Programming |
| Course Code | B23-MAT-503 |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | DSE |
| Level of the course | 300-399 |
| Pre-requisite for the course (if any) | Mathematics as a subject at level 4.0 |
| Course Learning Outcomes (CLOs): | **After completing this course, the learner will be able to:**<br>1. Understand the concepts of linear programming problems (LPP) and all other associated concepts. Learn to analyze and solve linear programming problems of real life situations using graphical method.<br>2. Have the procedural knowledge of Simplex method and attain the skills to apply knowledge of simplex method in solving real life LPP. Learn the techniques of Two-phase method and Big-M method.<br>3. Understand the concepts of dual problems, duality theorem and to attain skills to solve linear |

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| CLO 5 is related to the practical component of the course. | programming problems by making use of duality theorem.<br>4. Have the procedural knowledge of Transportation problems and Assignment problems. Acquire the skills to solve these problems by using different LPP methods.<br>5. Attain cognitive and technical skills required to analyze scientific and social problems as linear programming problems and solving them by applying learnt techniques. |

| Credits | Theory | Practical | Total |
|---|---|---|---|
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| Internal Assessment Marks | 20 | 10 | 30 |
| End Term Examination Marks | 50 | 20 | 70 |
| Examination Time | 3 Hours | 3 Hours | |

Max. Marks: 100

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

**Note:** The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Linear Programming Problems: Definition, Objective function, Constraints, Canonical and standard forms. Graphical approach for solving some linear programming problems, Limitations of graphical method. | 12 |

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| | Convex and polyhedral sets, Extreme points, Basic solutions, Basic feasible solutions. Correspondence between basic feasible solutions and extreme points. | |
| II | Theory of simplex method, Concept of initial basic feasible solution, Optimality criterion, Improving a basic feasible solution, Unboundedness.<br>Simplex algorithm and its tableau format, Artificial variables, Two-phase method, Big-M method. Relation between maximization and minimization problems, Solving linear programming problems using simplex algorithm. | 12 |
| III | Formulation of the dual problem, Duality theorems, Unbounded and infeasible solutions in the primal, Solving the primal problem using duality theory. | 12 |
| IV | Transportation Problem: Definition and formulation, Methods of finding initial basic feasible solutions, North West corner rule, Least cost method, Vogel's Approximation method.<br>Assignment Problem: Mathematical formulation and Hungarian method of solving. | 12 |
| **Practical** | | |
| | The practical component of the course has two parts, Problem Solving and Practical's using MATLAB/SCILAB or other Statistical software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.<br>**Part A:** Problem Solving-Questions related to the practical | 30 |

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applications based on following problems will be worked out and record of those will be maintained in the Practical Note Book:

1. To solve Linear Programming Problems using Graphical method with

(i) Unbounded solution.
(ii) Infeasible solution.
(iii) Alternate or multiple solutions.

2. Solving LPP using Simplex method with
(i) Unrestricted variables.
(ii) Infeasible solution.

3. To solve Linear Programming Problem by Simplex method with unique solution or with unbounded solution.

4. To solve Linear Programming Problem by Two Phase method.

5. To solve Linear Programming Problem by Big M-Method.

6. To solve Linear Programming Problem using duality.

7. To obtain an optimal solution by Dual Simplex Method.

8. To determine optimal solution of a transportation problem using Vogel's method.

9. To determine optimal solution of transportation problem using (u v) method.

10. To determine an initial basic feasible solution of transportation problem by matrix method.

11. To determine solution of Allocation problems using Assignment model.

**Part B:** Implementation of above mentioned problem solving through MATLAB/SCILAB or other Statistical softwares.

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| Suggested Evaluation Methods | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory 20**<br>• Class Participation: 5<br>• Seminar/presentation/assignment/quiz/class test etc.: 5<br>• Mid-Term Exam: 10<br>➢ **Practicum 10**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.: 10<br>• Mid-Term Exam: | **End Term Examination:**<br>➢ **Theory 50**<br>Written Examination<br>➢ **Practicum 20**<br>Lab record, viva-voce, write-up and execution of programs |

**Part C-Learning Resources**


1. F. S. Hillier, G. J. Lieberman, B. Nag and P. Basu (2021). *Introduction to Operations Research* (11th Edition). McGraw-Hill Education.
2. Hamdy A. Taha (2021). *Operations Research: An Introduction* (10th Edition). Pearson.
3. M. S. Bazaraa, J.J. Jarvis and H. D. Sherali (2010). *Linear Programming and Network Flows* (4th Edition). John Wiley & Sons Inc.
4. P. R. Thie and G. E. Keough (2008). *An Introduction to Linear Programming and Game Theory* (3rd Edition). Wiley Interscience.
5. G. Hadley (2002). *Linear Programming*. Narosa Publishing House.


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**DSE-2 Computer Programming**

**Session: 2023-24 (Scheme), 2025-26 (Syllabus)**

**Part A – Introduction**

| | |
|---|---|
| Subject | Mathematics |
| Semester | V |
| Name of the Course | Computer Programming |
| Course Code | B23-MAT-504 |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | DSE |
| Level of the course | 300-399 |
| Pre-requisite for the course (if any) | Mathematics as a subject at level 5.0 |
| Course Learning Outcomes (CLOs): | **After completing this course, the learner will be able to:**<br>1. Have a deeper knowledge and understanding of the concept of mathematical problem solving using computer programming, program design, documentation, compilation, debugging, linking and types of errors in programming.<br>2. Gain the knowledge and familiarize with the concepts of identifiers, constants, variables, data types, operators, input/output functions in C/C++ programming language. Attain the skills to write and execute programs in C/C++ using programming tools.<br>3. Have a deeper knowledge and understanding of |

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| CLO 5 is related to the practical component of the course. | decision control statements, loops structures, multidimensional arrays and dynamic arrays in C/C++ programming language.<br>4. Gain the knowledge and deeper understanding of functions, pointers, strings and files in C/C++ language. Attain the programming skills to solve scientific and practical problem using programming tools.<br>5. Attain skills of writing codes in the C/C++ programming language. Have hands-on experience to run and debug programs in C/C++ for different mathematical and other practical problems of daily or scientific use. |

| Credits | Theory | Practical | Total |
|---|---|---|---|
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| Internal Assessment Marks | 20 | 10 | 30 |
| End Term Examination Marks | 50 | 20 | 70 |
| Examination Time | 3 Hours | 3 Hours | |

Max. Marks: 100

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

**Note:** The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

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| Unit | Topics | Contact Hours |
|---|---|---|
| I | Planning the Computer Program: Concept of problem solving, Problem definition, Program design, Debugging, Types of errors in programming, Documentation. Techniques of Problem Solving: Flowchart, Algorithms, Pseudo code, Decision table, Structured programming concepts, Programming methodologies viz. top-down and bottom-up programming.<br>Computer Languages: Analogy with natural language, Machine language, Assembly language, High level language, Compiler, Interpreter, Assembler, Characteristics of a good programming language. | 12 |
| II | Basic Structure of programming in C/C++, Creating C/C++ source file, Editing, Compiling, Debugging, linking etc., Tokens, Keywords, Identifiers, Constants and Variables in C/C++, Scope and lifetime of variables, Data types in C/C++, Operators and Enum in C/C++, Operators precedence, Arithmetic Expressions, Input/ Output functions in C/C++. | 12 |
| III | Decision making using IF statement, Types of IF-ELSE block, Switch case block.<br>Loop structures: While loop, Do-While Loop, For Loop, Continue statement, Break statement.<br>Introduction of Array, Multidimensional Arrays, Dynamic Arrays. | 12 |
| IV | Concept of function in C/C++, User defined function, System defined function, Types of parameters passing in function.<br>Implementing string variables, String handling functions in C/C++.<br>Need of Pointers, Types of pointers, Pointers expressions, Arrays of Pointers, Pointers and Functions, File handling | 12 |

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| | using C/C++ | |
| **Practical** | | |
| | This course has programs, based on Programming in C/C++. The examiner will set 4 programs at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to execute two programs. The evaluation will be done on the basis of practical record, viva-voce, write-up and execution of the program.<br><br>**Practicals**: The following practicals will be done using the programming language C/C++ and record of those will be maintained in the practical Note Book:<br><br>1. Program to find the largest number among n input numbers.<br>2. Program to find first nPrime Numbers.<br>3. Program to print hollow pyramid star pattern.<br>4. Program to convert a decimal number to binary.<br>5. Program to generate Fibonacci Triangle.<br>6. Programs to find sum of an AP and GP Series.<br>7. Program to remove Duplicate Element in an Array.<br>8. Program to check whether a two dimensional array is a Sparse Matrix.<br>9. Find Norm and Trace of a Square Matrix.<br>10. Program to find GCD of two Numbers using Recursion.<br>11. Program to check if input character is a vowel using Switch Case.<br>12. Program to Check if a given string is Palindrome.<br>13. Program to Count the number of vowels & consonants in a sentence.<br>14. Program for dynamic memory allocation using malloc(). | 30 |

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| | 15. Program to swap two numbers using Pointers.<br>16. Program for accessing array elements (Traversing array) by incrementing a Pointer.<br>17. Program for Pointer to a Function.<br>18. Program for sorting an array.<br>19. Program for searching an element in an array. | |

**Suggested Evaluation Methods**

| | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory 20**<br>• Class Participation: 5<br>• Seminar/presentation/assignment/quiz/class test etc.: 5<br>• Mid-Term Exam: 10<br>➢ **Practicum 10**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.: 10<br>• Mid-Term Exam: | **End Term Examination:**<br>➢ **Theory 50**<br>Written Examination<br>➢ **Practicum 20**<br>Lab record, viva-voce, write-up and execution of programs |

**Part C-Learning Resources**

**Recommended Books:**


1. E. Balagurusamy (2020). *Object Oriented Programming with C++* (8th Edition). McGraw Hill Education.
2. E. Balagurusamy (2019). *Programming in ANSI C* (8th Edition). McGraw Hill Education.
3. D.S. Malik (2017). *C++ Programming: From Problem Analysis to Program Design* (8th Edition). Cengage Learning.
4. B. Gottfried (2017). *Programming with C (Schaums Outline series)* (3rd Edition). McGraw Hill Education.
5. R. Thareja (2016). *Computer Fundamentals and Programming in C* (2nd Edition), Oxford University Press.
6. S. Prata (2015). *C++ Primer Plus* (6th Edition). Pearson Education India.
7. B.W. Kernighan and D.M Ritchie (2015). *The C Programming Language* (2nd Edition). Pearson Education India.
8. V. Rajaraman (1994). *Computer Programming in C*. Prentice Hall of India.


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DSE-3 Number Theory and Cryptography

| Session: 2023-24 (Scheme), 2025-26 (Syllabus) | |
|---|---|
| **PartA – Introduction** | |
| Subject | Mathematics |
| Semester | V |
| Name of the Course | Number theory and cryptography |
| Course Code | B23-MAT-505 |
| CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | DSE |
| Level of the course | 300-399 |
| Pre-requisite for the course (ifany) | Level 200-299 |
| CourseLearningOutcomes(CLOs): | After completing this course, the learner will be able to:<br>1. Understand the notion of divisibility, Euclidean algorithim, congruences and some applications to factoring.<br>2. Have knowledge of Finite fields, quadratic residues and quadratic reciprocity.<br>3. Have deeper knowledge and understanding of cryptosystems and enciphering matrices.<br>4. Understand and solve problems related to Public key cryptography, RSA, discrete log and knapsack problem. |

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| CLO 5 is related to the practical component of the course. | 5. Attain cognitive and technical skills required for solving practical problems related to Euclidean algorithim, linear congruences, divisibility, finite field, Deciphering the ciphertext, integer factorization, RSA encryption and decryption functions. | | |
| Credits | Theory | Practical | Total |
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| Internal Assessment Marks | 20 | 10 | 30 |
| End term Examination Marks | 50 | 20 | 70 |
| Examination Time | 3 Hours | 3 Hours | |

Max. Marks:100

**PartB-Contentsofthe Course**

**Instructions for Paper- Setter**

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Numbers in different bases, divisibility and the Euclidean algorithim, congruences, some applications to factoring. | 12 |
| II | Finite fields, quadratic residues and quadratic reciprocity. | 12 |
| III | Some simple cryptosystems, enciphering matrices. | 12 |

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| IV | Public key cryptography, RSA cryptosystems, discrete log and knapsack problem. | 12 |
| | Practical | |
| | The practical component of the course has two parts, Problem Solving and Practical's using MATLAB/SCILAB or other Statistical software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.<br>**Part A:** Problem Solving-Questions related to the practical applications based on following problems will be worked out and record of those will be maintained in the Practical Note Book:<br>1. To find the gcd using Euclidean algorithim.<br>2. Find common solution of linear congruences using Chinese remainder theorem.<br>3. Checking the divisibility of an integer by another integer.<br>4. Find the generator of a finite field.<br>5. To find the square root of a number in finite field.<br>6. Check that a given number is quadratic residue or quadratic non residue modulo a prime number.<br>7. Deciphering the ciphertext. | 30 |

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| | 8. Integer Factorisation.<br>9. Find the smallest field extension of $F_5$ which contains all the roots of the polynomial $X^2 + X + 1$.<br>10. Given two prime number p and q find the modulus n and the public and private keys for RSA encryption and decryption.<br>11. Implement the RSA encryption and decryption functions in a problem.<br>12. Given two elements a and b in a finite field $F_p$, compute their sum, product, and multiplicative inverse.<br>**Part B:** Implementation of above mentioned problem solving through MATLAB/SCILAB or other softwares. | |

**Suggested Evaluation Methods**

| | |
|---|---|
| **InternalAssessment:**<br>➢ **Theory 20**<br>• Class Participation: 5<br>• Seminar/presentation/assignment/quiz/class test etc.: 5<br>• Mid-Term Exam: 10<br>➢ **Practicum 10**<br>• Class Participation<br>• Seminar/Demonstration/Viva-voce/Lab records etc.: 10<br>• Mid-Term Exam | **End Term Examination:**<br>➢ **Theory 50**<br>Written Examination<br>➢ **Practicum 20**<br>Lab record, viva-voce, write up and execution of the program |

**PartC-Learning Resources**

**Recommended Books:**


1. N. Koblitz, (1994). *A Course in Number Theory and Cryptography* (2nd edition). Springer-Verlag.

2. M. W. Baldoni, C. Ciliberto, G. M. PiacentiniCattaneo, (2009). *Elementary Number Theory, Cryptography and Codes*. Springer Berlin, Heidelberg.

3. W. Stallings, (2017).*Cryptography and network security* (7th edition). Pearson Education.


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DSE-3 Integral Transforms and Fourier Analysis

| Session: 2023-24 (Scheme), 2025-26 (Syllabus) | |
|---|---|
| **Part A – Introduction** | |
| Subject | Mathematics |
| Semester | V |
| Name of the Course | Integral Transforms and Fourier Analysis |
| Course Code | B23-MAT-506 |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | DSE |
| Level of the course | 300-399 |
| Pre-requisite for the course (if any) | Mathematics as a subject at level 5.0. |
| Course Learning Outcomes (CLO): | **After completing this course, the learner will be able to:**<br><br>1. Gain the knowledge and understanding of Laplace transforms, Inverse Laplace transforms, their properties and convolution theorem.<br>2. Have the knowledge of Fourier series, Fourier sine and cosine series, Fourier half range series and absolute and uniform convergence of Fourier series. Learn Parseval's identity and Bessel's inequality. Attain skills to make use of Fourier series in scientific problem solving.<br>3. Gain the deeper knowledge of Fourier transforms, inverse Fourier transforms, their properties and Convolution theorem. Learn about the concept of finite Fourier transforms, inverse finite Fourier transforms |

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| | and attain the skills to apply Fourier transforms techniques to solve mathematical and scientific problems.<br>4. Have the procedural knowledge and attain the skills to solve differential equations, partial differential equations, boundary value problems and integral equations using Integral transforms. |
| CLO 5 is related to the practical component. | 5. Attain the cognitive and technical skills required for performing and accomplishing complex tasks related to solution of differential equations, boundary value problems and integral equations using Laplace transforms and Fourier Transforms. Acquire analytical and numerical skills to solve mathematical and scientific models involving Integral transforms. |

| | Theory | Practical | |
|---|---|---|---|
| Credits | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| Internal Assessment Marks | 20 | 10 | 30 |
| End Term Exam Marks | 50 | 20 | 70 |
| Examination Time | 3Hrs | 3Hrs | |

Max. Marks: 100

**Part B-Contents of the Course**

**Instructions for Paper- Setter**

**Note:** The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

Unit

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| Unit | Topics | Contact Hours |
|---|---|---|
| I | Introduction to Integral transforms. Laplace transforms: Existence theorem for Laplace transforms, Linearity, change of scale and shifting properties of the Laplace transforms, Laplace transforms of some standard functions, Laplace transforms of derivatives and integrals, Differentiation and integration of Laplace transforms, Laplace transforms of periodic functions and some special functions. Convolution theorem, Inverse Laplace transforms and its properties. | 12 |
| II | Fourier series, Fourier series of even and odd functions, Fourier half-range series, Fourier cosine and sine series, Parseval's identity, Differentiation and integration of Fourier series, Absolute and uniform convergence of Fourier series, Bessel's inequality, the complex form of Fourier series. | 12 |
| III | Fourier transforms, Fourier sine and cosine transforms, Linearity, Change of scale and Shifting properties, Fourier transforms of derivatives, Modulation theorem, Relation between Fourier and Laplace transforms, Convolution theorem for Fourier transform, Parseval's identity for Fourier transforms, , Finite Fourier transform, Inversion formula for finite Fourier transforms. Inverse Fourier transforms, Inverse Fourier sine and cosine transforms. | 12 |
| IV | Applications of Laplace transform in obtaining solutions of ordinary differential equations and integral equations. Solution of integral equation by Fourier sine and cosine transforms, Applications of infinite and finite Fourier | 12 |

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| | transforms to boundary value problems. | |
| | **Practical** | |
| | The practical component of the course has two parts, Problem Solving and Practical's using MATLAB/ SCILB/MAXIMA software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.<br><br>**(A) Problem Solving-** Questions related to the following problems will be solved and record of those will be maintained in the Practical Notebook:<br>1. Practical problems to determine Laplace transform.<br>2. Practical problems of finding inverse Laplace transform.<br>3. Practical problems for finding Fourier half-range series.<br>4. Practical problems for finding Fourier cosine and sine series.<br>5. Practical problems for finding finite Fourier transform.<br>6. Practical problems to solve differential equations by Laplace transform method.<br>7. Practical problems to solve partial differential equations by Fourier transform method.<br>8. Practical problems to solve integral equations by Fourier transform method. | 30 |

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| | **(B) The following practicals will be done using MATLAB/ SCILAB/MAXIMA software and record of those will be maintained in the practical note book:**<br><br>1. Practical problems for computing Laplace transforms of symbolic expressions with or without specifying independent and transformation variables.<br><br>2. Practical problems for computing Laplace transform of Dirac and Heaviside function.<br><br>3. Practical problems for computing Inverse Laplace of symbolic expressions.<br><br>4. Practical problems for computing Fourier and Inverse Fourier transforms of symbolic expressions.<br><br>5. Practical problems for computing Fourier transform of Bessel's function.<br><br>6. Practical problems based on solving differential equations using Laplace transform.<br><br>7. Practical problems based on solving partial differential equations using Fourier transform.<br><br>8. Practical problems based on computing Fourier series of odd and even functions. | |

| **Suggested Evaluation Methods** | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory 20**<br>• Class Participation: 5<br>• Seminar/presentation/assignment/quiz/class test etc.: 5<br>• Mid-Term Exam: 10<br>➢ **Practicum 10**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.: 10<br>• Mid-Term Exam: | **End Term Examination:**<br>➢ **Theory 50**<br>Written Examination<br>➢ **Practicum 20**<br>Lab record, viva-voce, write-up and execution of programs |

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## Part C-Learning Resources

**Recommended Books:**


1. W. Rudin (2017). *Fourier Analysis on Groups*. Dover Publications Inc.
2. J. W. Brown and R.V. Churchill (2011). *Fourier Series and Boundary Value Problems* (8th Edition). McGraw-Hill Higher Education.
3. E. Kreyszig (2011). *Advanced Engineering Mathematics* (10th Edition). Wiley.
4. M.R. Spiegel (2005). *Laplace Transforms*. Schaum's Outline Series. McGraw Hill Education.
5. A. Zygmund (2003). *Trigonometric Series* (3rd Edition). Cambridge University Press.
6. C. K. Chui (1992). *An Introduction to Wavelets*. Academic Press.
7. I.N. Sneddon (1974). *The Use of Integral Transforms*. McGraw Hill Inc., US.


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**CC-6/ MCC-11** Numerical Analysis

| **Session: 2023-24 (Scheme), 2025-26 (Syllabus)** | |
|---|---|
| **Part A – Introduction** | |
| Subject | Mathematics |
| Semester | VI |
| Name of the Course | Numerical Analysis |
| Course Code | B23-MAT-601 |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | CC/MCC |
| Level of the course | 300-399 |
| Pre-requisite for the course (if any) | Mathematics as a subject at level 4.5 |
| Course Learning Outcomes (CLOs): | **After completing this course, the learner will be able to:**<br>1. Understand the different types of errors, learn techniques to obtain numerical solutions of algebraic and transcendental equations.<br>2. Have the knowledge and attain numerical skills to find solutions of system of linear equations by different methods.<br>3. Gain the knowledge to understand the concept of interpolation and extrapolation. Learn various numerical methods to find the value of function and their derivatives using interpolation concept.<br>4. Have the procedural knowledge and acquire the |

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| CLO 5 is related to the practical component of the course. | skills to apply numerical methods for evaluating definite integrals. Learn single step and multi-step methods to solve first order ordinary differential equations.<br><br>5. Attain cognitive and technical skills required to solve scientific problems by applying numerical techniques. Learn to write and execute program of numerical methods based on C language. |

| Credits | Theory | Practical | Total |
|---|---|---|---|
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| Internal Assessment Marks | 20 | 10 | 30 |
| End Term Examination Marks | 50 | 20 | 70 |
| Examination Time | 3 Hours | 3 Hours | |

Max. Marks: 100

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

**Note:** The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Round-off error and computer arithmetic, Local and global truncation errors, Algorithms and convergence. Numerical methods for solving algebraic and transcendental equations: Bisection method, False position method, Fixed point iteration method, Newton-Raphson | 12 |

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| | method and Secant method.<br>Newton's iterative method for finding nth root of a number. | |
| II | Numerical methods for solving simultaneous linear equations: Gauss-elimination method, Gauss-Jordan method, Triangularization method (LU decomposition method), Crout's method, Cholesky decomposition method. Iterative methods: Jacobi's method, Gauss-Seidal method, Relaxation method. | 12 |
| III | Finite Differences operators and their relations. Interpolation with equal intervals: Gregory–Newton forward and backward difference interpolations.<br>Interpolation with unequal intervals: Newton's divided difference formulae, Lagrange's Interpolation formulae.<br>Central Differences: Gauss forward and Gauss backward interpolation formulae, Sterling formula, Bessel's formula.<br>Piecewise linear interpolation, Cubic spline interpolation.<br>Numerical Differentiation: First and second derivative of a function using interpolation formulae. | 12 |
| IV | Numerical Integration: Newton-Cote's Quadrature formula, Trapezoidal rule, Simpson's one-third and three-eighth rule, Chebychev formula, Gauss Quadrature formula.<br>Numerical solution of ordinary differential equations: Single step methods-Picard's method, Taylor's series method, Euler's method, Runge-Kutta Method.<br>Multiple step methods: Predictor-corrector method, Modified Euler's method, Milne-Simpson's method. | 12 |

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| | Practical | |
|---|---|---|
| | This course has programs, based on Programming in C, related to Numerical methods to solve mathematical problems. The examiner will set 4 programs at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to execute two programs. The evaluation will be done on the basis of practical record, viva-voce, write-up and execution of the program.<br><br>**Practicals**: The following practicals will be done using the programming language C and record of those will be maintained in the practical Note Book:<br><br>1. To find roots of algebraic and transcendental equations using Bisection method.<br>2. To find roots of algebraic and transcendental equations using Newton Raphson method.<br>3. To find roots of algebraic and transcendental equations using RegulaFalsi method.<br>4. To find solution of system of equations using Gauss Elimination method.<br>5. To find solution of system of equations using Gauss Seidal method.<br>6. To find approximate value of a function by Newton Forward Interpolation formula.<br>7. To find approximate value of a function by Newton Backward Interpolation formula.<br>8. To find approximate value of a function using Lagrange's Interpolation formula. | 30 |

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| | 9. To find first and second order derivatives using interpolation formulas.<br>10. To evaluate a definite integral using Trapezoidal Rule.<br>11. To evaluate a definite integral using Simpson 1/3 rule.<br>12. To evaluate a definite integral using Simpson 3/8 rule.<br>13. To solve an ordinary differential equation using Euler's method.<br>14. To find solution of an ordinary differential equation using modified Euler's method.<br>15. To solve an ordinary differential equation using Runge-Kutta second order and fourth order methods. | |

**Suggested Evaluation Methods**

| | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory 20**<br>• Class Participation: 5<br>• Seminar/presentation/assignment/quiz/class test etc.: 5<br>• Mid-Term Exam: 10<br>➢ **Practicum 10**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.: 10<br>• Mid-Term Exam: | **End Term Examination:**<br>➢ **Theory 50**<br>Written Examination<br>➢ **Practicum 20**<br>Lab record, viva-voce, write-up and execution of programs |

**Part C-Learning Resources**

**Recommended Books:**


1. Gupta, R.K, (2019) *Numerical Methods: Fundamentals and Applications* Cambridge University Press.
2. A. Gupta and S.C. Bose (2012). *Introduction to Numerical Analysis* (3rd Edition). Academic Publishers.


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3. M.K. Jain, S. R. K. Iyengar and R. K. Jain (2012). *Numerical Methods for Scientific and Engineering Computation* (6th Edition). New Age International Publishers.
4. B. Bradie (2007). *A Friendly Introduction to Numerical Analysis*. Pearson India.
5. C. F. Gerald and P. O. Wheatley (2007). *Applied Numerical Analysis* (7th Edition). Pearson Education India.
6. F.B. Hildebrand (2003). *Introduction to Numerical Analysis* (2nd edition). Dover Publication Inc.
7. R. J. Schilling and S. L. Harris (1999). *Applied Numerical Methods for Engineers using MATLAB and C*. S. Chand (G/L) & Company Ltd.

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## MCC- 12 Real Analysis

| Session: 2023-24 (Scheme), 2025-26 (Syllabus) | |
|---|---|
| **PartA – Introduction** | |
| Subject | Mathematics |
| Semester | VI |
| Name of the Course | Real Analysis |
| Course Code | B23-MAT-602 |
| CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | MCC |
| Level of the course | 300-399 |
| Pre-requisite for the course (ifany) | Courses on Calculus and Advanced Calculus |
| CourseLearningOutcomes(CLO):<br><br>CLO 5 is related to the practical component of the course. | **After completing this course, the learner will be able to:**<br>1. Learn basic theory of Riemann integration, and understand fundamental theorem and mean valuetheoremofintegralcalculus.<br>2. Understand the notion of improper integral and learn to test the convergence of improper integrals. Apply Leibnitz's rule of differentiation under integral sign to compute various integrals.<br>3. Have knowledge of distance function (metric) and grasp the basic definitions and theorems based on metric and metric space. Apply the knowledge of distance function to check the convergence of sequence in a metric space.<br>4. Understand the concepts of continuity, compactness, and connectedness in a metric space and analyze the same on real line with usual metric.<br>5. Attain cognitive and technical skill required to trace the open (closed) sphere in a metric space and observe the effect of different metrics on the same space. Apply the technical tool to check the convergence of real sequences. |

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| Credits | Theory | Practical | Total |
|---|---|---|---|
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| Internal Assessment Marks | 20 | 10 | 30 |
| End Term Examination Marks | 50 | 20 | 70 |
| Examination Time | 3 Hours | 3 Hours | |

Max. Marks:100

**PartB-Contentsofthe Course**

**Instructions for Paper- Setter**

**Note:** The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Riemann integral, Integrability of continuous and monotonic functions, The fundamental theorem of integral calculus, Mean value theorems of integral calculus. | 12 |
| II | Improper integrals and their convergence, Comparison tests, Abel's and Dirichlet's tests, Frullani's integral, Integral as a function of a parameter. Fourier series: Fourier expansion of piecewise monotonic functions, Properties of Fourier coefficients, Dirichlet's conditions, Parseval's identity for Fourier series, Half range series, Change of intervals. | 12 |
| III | Definition and examples of metric spaces, neighborhoods, interior points, limit points, open and closed sets, closure and interior of a set, boundary points, subspace of a metric space, equivalent metrics, Cauchy sequences, completeness, Cantor's intersection theorem, Baire's category theorem, contraction principle. | 12 |
| IV | Continuous functions, uniform continuity, compactness for metric spaces, sequential compactness, Bolzano-Weierstrass property, total boundedness, finite intersection property, continuity in relation with compactness, connectedness, components, continuity in relation with connectedness. | 12 |

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| | Practical | |
|---|---|---|
| | The practical component of the course has two parts, Problem Solving and Practical's using Mathematica/ MATLAB/Maple/SCILAB/ Maxima etc. software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (CLO) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.<br>**(A) Problem Solving-** Questions related to the following problems will be solved and their record will be maintained in the Practical Notebook:<br>1. Problem solving to compute upper and lower sums of a bounded function for a given partition of a closed interval.<br>2. Practical problems to check the Riemann integrability of a bounded function.<br>3. Problem solving to compute the Riemann integrals of a bounded functions using definition.<br>4. Practical problems to estimate the value of an integral using mean value theorem.<br>5. Problem solving to check the convergence of improper integrals.<br>6. Problem solving to compute the integral using Leibnitz's rule of differentiation under integral sign.<br>8. Problem solving on the Fourier series expansion of periodic functions.<br>7. By means of an example demonstrate that a subset which is<br>(a) Open in a subspace need not be open in the space.<br>(b) Closed in a subspace need not be closed in the space.<br>8. Show by an example that real line with usual metric is not compact. | 30 |

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| | **(B) The following practical's will be done using Mathematica / MATLAB/Maple/SCILAB/Maxima etc.software and their record will be maintained in the practical note book:**<br>1. Trace the open and closed spheres in Euclidean space $\mathbb{R}^n$ for n = 2 and n = 3.<br>2. Trace the open (closed) sphere for same centre and same radius in $\mathbb{R}^2$ for two different metrics.<br>3. Problems on convergence of sequences in usual metric space.<br>4. Problems on definite integral of bounded function on closed interval and verify the same theoretically.<br>5. Problems on Fourier series expansion of periodic functions.<br>6. Trace the Cartesian curve and find the area under the curve. | |

**SuggestedEvaluationMethods**

| | |
|---|---|
| **InternalAssessment:**<br>➢ **Theory 20**<br>• Class Participation: 5<br>• Seminar/presentation/assignment/quiz/class test etc.: 5<br>• Mid-Term Exam: 10<br>➢ **Practicum 10**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.: 10<br>• Mid-Term Exam: | **End Term Examination:**<br>➢ **Theory 50**<br>Written Examination<br>➢ **Practicum 20**<br>Lab record, viva-voce, write up and execution of the program |

**PartC-Learning Resources**

**Recommended Books:**


1. T. M. Apostol (1985). *Mathematical Analysis*. Narosa Publishing House, New Delhi.

2. Charalambos D. Aliprantis& Owen Burkinshaw (1998). *Principles of Real Analysis* (3rd edition). Academic Press.

3. Robert G. Bartle & Donald R. Sherbert (2015). *Introduction to Real Analysis* (4th edition). Wiley India.

4. Gerald G. Bilodeau, Paul R. Thie& G. E. Keough (2015). *An Introduction to Analysis* (2nd edition), Jones and Bartlett India Pvt. Ltd.

5. E. Hewitt & K. Stromberg (2013). *Real and Abstract Analysis*. Springer-Verlag.

6. K. A. Ross (2013). *Elementary Analysis: The Theory of Calculus* (2nd edition). Springer.


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7. R. R. Goldberg (1970). *Real Analysis*. Oxford & I. B. H. Publishing Co., New Delhi.

8. Shanti Narayan & P. K. Mittal (2005). *A Course in Mathematical Analysis* . S. Chand and company, New Delhi.

9. S. C. Malik & S. Arora (2021) . *Mathematical Analysis*. Wiley Eastern Ltd., Allahabad.

10. E. T. Copson (1988). *Metric Spaces*. Cambridge University Press.

11. P. K. Jain &Kalil Ahmad (2019). *Metric spaces*. Narosa Publishing House, New Delhi.

12. S. Kumaresan (2011). *Topology of Metric spaces*($2^{nd}$ edition). Narosa Publishing House, New Delhi.

13. G. F. Simmons(2004). *Introduction to Topology and Modern Analysis*. McGraw –Hill.

14. SatishShirali& H. L. Vasudeva (2006). *Metric spaces*. Springer-Verlag.

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DSE-4 Mechanics-II

| Session: 2023-24 | |
|---|---|
| **PartA - Introduction** | |
| Subject | Mathematics |
| Semester | VI |
| Name of the Course | Mechanics-II |
| Course Code | B23-MAT-603 |
| CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | DSE |
| Level of the course | 300-399 |
| Pre-requisite for the course (ifany) | Course on Mechanics-I |
| CourseLearningOutcomes(CLO): | After completing this course, the learner will be able to:<br>1. Gain comprehensive understanding of the necessary conditions for the equilibrium of a body acted upon by forces in plane, and learns the principle of virtual work for a system of coplanar forces acting on a rigid body and central axis. Apply this knowledge to investigate, analyze and solve scientific problems.<br>2. Have deeper knowledge and understanding of three dimensional force system, central axis, and wrenches and learn about null point, null lines and null planes with respect to a system of forces acting on a rigid body together with the idea of central axis. |

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| CLO 5 is related to the practical component of the course. | 3. Have knowledge of projectile motion, particle motion on a smooth or rough path in a plane and apply the knowledge for problem solving.<br>4. Understand equation of motion of a body moving under central forces, Kepler's laws of the planetary motions and their relations with Newton's laws of Motion. Solve problems of central orbits and planetary motion using procedural knowledge of these laws.<br>5. Attain cognitive and technical skills to solve practical problems of virtual work, principle of virtual work, wrenches and central orbits. Have hands on skill to create simple program in SCILAB/MATLAB to find time of flight, horizontal range of projectile motion. |

| Credits | Theory | Practical | Total |
|---|---|---|---|
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| Internal Assessment Marks | 20 | 10 | 30 |
| End term Examination Marks | 50 | 20 | 70 |
| Examination Time | 3 Hours | 3 Hours | |

Max. Marks:100

**PartB-Contentsofthe Course**

**Instructions for Paper- Setter**

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

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| Unit | Topics | Contact Hours |
|---|---|---|
| I | Analytical conditions of equilibrium of coplanar force, Virtual work. | 12 |
| II | Forces in three dimensions, Poinsot's central axis, Wrenches, Null lines and Null planes. | 12 |
| III | Projectile motion of a particle in a plane, Motion on smooth and rough plane curves. | 12 |
| IV | Central Orbit, Kepler's laws of planetary motion and their relation with Newton's laws of motion. | 12 |
| | **PRACTICAL** | |
| | The practical component of the course has two parts, Problem Solving and Practical's using SCILAB/MATLAB software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (CLO) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.<br><br>**(A) Problem Solving-** Questions related to the following problems will be solved and their record will be maintained in the Practical Notebook:<br>1. Practical problems to understand principle of virtual work for a system of coplanar forces acting on a | 30 |

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| | particle.<br>2. Practical problems to determine equilibrium of a body under coplanar forces.<br>3. Practical problems to understand wrenches, screw, poinsot's central axis and pitch of the system.<br>4. Practical problems to find velocity at any point of the trajectory.<br>5. Practical problems to determine range and time of flight of a particle on an inclined plane.<br>6. Practical problems to determine central orbits when the law of central force is given.<br>7. Practical problems related to elliptic, hyperbolic and parabolic orbit.<br>8. Practical problems to establish the equivalence of Kepler's laws for planetary motion and Newton's law of Gravitation.<br>**(B) The following practicals will be done using SCILAB/MATLAB software and their record will be maintained in the practical note book:**<br>Represent forces in 3D space using vectors.<br>Given a set of forces acting in 3D space, find the resultant force and check for equilibrium.<br>Calculate the moment about different axes and verify if the system is in equilibrium.<br>Simulate the trajectory of a projectile launched at a given angle and initial velocity. Plot the trajectory using MATLAB/SCILAB's plotting functions, and calculate parameters such as time of flight, maximum height (vertex), and range.<br>Write MATLAB/SCILAB code to calculate the time | |

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| | of flight of a projectile launched at a given angle and initial velocity, neglecting air resistance. Verify the result by comparing it with analytical solutions.<br>Determine the maximum height reached by the projectile during its flight using MATLAB/SCILAB. Plot the trajectory and identify the vertex, then calculate the corresponding height.<br>Develop MATLAB/SCILAB code to calculate the horizontal range of a projectile launched at a given angle and initial velocity. Compare the result with analytical solutions and explore the effect of launch angle on range.<br>Study how the initial velocity of the projectile affects its time of flight, maximum height, and range. Plot these parameters as functions of initial velocity using MATLAB/SCILAB. | |

**Suggested Evaluation Methods**

| | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory 20**<br>• Class Participation: 5<br>• Seminar/presentation/assignment/quiz/class test etc.: 5<br>• Mid-Term Exam: 10<br>➢ **Practicum 10**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.: 10<br>• Mid-Term Exam: | **End Term Examination:**<br>➢ **Theory 50**<br>Written Examination<br>➢ **Practicum 20**<br>Lab record, viva-voce, write up and execution of the program |

**Part C-Learning Resources**

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**Recommended Books/e-resources/LMS:**


12. Stephan J. Chapman (2020). *MATLAB Programming for Engineers* (6th edition). Cengage Learning.
13. William Palm Lii (2017). *A Concise Introduction to MATLAB* (2nd edition). Tata Mcgraw-Hill Education.
14. RudraPratap (2010). *Getting Started with MATLAB:A quick introduction for scientists and engineers.* Oxford University Press.
15. A. S. Ramsey (2009). *Statics*. Cambridge University Press.
16. A. S. Ramsey (2009). *Dynamics*. Cambridge University Press.
17. S.L. Loney (2006). *An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies*. Read Books.
18. A.P. Roberts (2003). *Statics and Dynamics with Background in Mathematics*. Cambridge University Press.
19. S.L. Loney (1995). *An Elementary Treatise on Statics*, Radha Publishing House.
20. P.L. Srivastava (1964). *Elementary Dynamics*. Ram NarainLal, Beni Prasad Publishers Allahabad.
21. R. S. Varma (1962). *A Text Book of Statics*. Pothishala Pvt. Ltd.
22. J. L. Synge & B. A. Griffith (1949). *Principles of Mechanics*. McGraw-Hill.


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DSE-4 Classical Mechanics

**Session: 2023-24 (Scheme), 2025-26 (Syllabus)**

**PartA - Introduction**

| | |
|---|---|
| Subject | Mathematics |
| Semester | VI |
| Name of the Course | Classical Mechanics |
| Course Code | B23-MAT-604 |
| CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | DSE |
| Level of the course | 300-399 |
| Pre-requisite for the course (ifany) | Course on Mechanics-I |
| CourseLearningOutcomes(CLO): | After completing this course, the learner will be able to:<br>1. Learn calculus of variation, Brachistochrone problem, isoperimetric problems, and geodesic etc.<br>2. Understand stationary paths of a functional, Euler's equation, variational problems involving functionals depending on multi variables and on higher derivatives with different types of boundary conditions, and solving physical problems based on these cases.<br>3. Understand the concepts of constaints, generalized coordinates, holonomic and non-holonomic systems in classical mechanics, and Lagrangian and, Hamiltonian mechanics.<br>4. Understand D'Alembert's Principle and its application, Poisson bracket, Lagrange's equations, Gyroscopic, potential, dissipative forces and their importance in practical problems of mechanics. |

CLO 5 is related to component of th

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|---|---|---|---|
| CLO 5 is related to the practical component of the course. | 5. Exploring practical problems of Calculus of variation and Analytical Mechanics inculcate skill to handle real life problems based on these. | | |
| Credits | Theory | Practical | Total |
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| Internal Assessment Marks | 20 | 10 | 30 |
| End term Examination Marks | 50 | 20 | 70 |
| Examination Time | 3 Hours | 3 Hours | |

Max. Marks:100

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Motivating problems of calculus of variations: shortest distance, Minimum surface of revolution, Brachistochrone problem, Isoperimetric problem, Geodesic. Fundamental Lemma of calculus of variation. | 12 |
| II | Euler's equation for one dependent function of one and several independent variables, and its generalization to (i) Functional depending on 'n' dependent functions, (ii) Functional depending on higher order derivatives. Variational derivative, invariance of Euler's equations, natural boundary conditions and transition conditions, | 12 |

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|---|---|---|
| | Conditional extremum under geometric constraints and under integral constraints . Variable end points. | |
| III | Free and constrained systems, constraints and their classification. Generalized coordinates. Holonomic and Non-Holonomic systems. Scleronomic and Rheonomic systems. Generalized Potential, Possible and virtual displacements, ideal constraints. Lagrange's equations of first kind, Principle of virtual displacements, Hamilton's Principle, Derivation of Lagrange equations from Hamilton's principle. Extension of principle to nonholonomic systems. Conservation theorems and symmetry properties. | 12 |
| IV | Routh's procedure and oscillations about steady motion, The Hamiltonian formulation of relativistic mechanics, The Principle of least action.D'Alembert's principle, Holonomic Systems independent coordinates, generalized forces, Lagrange's equations of second kind. Uniqueness of solution. Theorem on variation of total energy. Potential, Gyroscopic and dissipative forces, Lagrange's equations for potential forces equation for conservative fields. The equations of canonical transformation. Examples of canonical transformation. The symplectic approach to canonical transformations. Poisson brackets and other canonical invariants. | 12 |
| | **PRACTICAL** | |
| | **The examiner will set 4 questions at the time of practical examination asking two questions by taking** | 30 |

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**course learning outcomes (CLOs) into consideration. The examinee will be required to solve two problems. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.**

Problem Solving: Questions related to the following problems will be worked out and record of those will be maintained in the Practical Notebook:

1. Practical problems to find geodesics on a surface.
2. Problem solving of isoperimetric problems.
3. Formulation and solution of the variational problems with several variables as functions of a single independent variable.
4. Formulation and solution of the variational problem in which higher order derivatives are involved in a functional.
5. Solve numerical problems related to Lagrange's equation.
6. Formulation and solution of real life situations which uses mathematical knowledge and characteristics of D's Alembert's Principle.
7. Solution of problems based on Lagrange's equation.
8. Solution of problems based on Hamilton's equation.

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| Suggested Evaluation Methods | |
|---|---|
| **InternalAssessment:**<br>➢ **Theory 20**<br>• Class Participation: 5<br>• Seminar/presentation/assignment/quiz/class test etc.: 5<br>• Mid-Term Exam: 10<br>➢ **Practicum 10**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.: 10<br>• Mid-Term Exam: | **End Term Examination:**<br>➢ **Theory 50**<br>Written Examination<br>➢ **Practicum 20**<br>Lab record, viva-voce, write up and execution of the program |

**PartC-Learning Resources**

**Recommended Books/e-resources/LMS:**


1. H. Goldstein, C.P. Poole & J.L. Safko (2011). *Classical Mechanics* (3rd edition), Pearson.
2. I.M. Gelfand and S.V. Fomin (2012). *Calculus of Variations*, Dover Publications.
3. S.K. Sinha (2009). *Classical Mechanics*, Alpha Science International Limited.
4. Louis N. Hand and Janet D. Finch (2008). *Analytical Mechanics*, Cambridge University Press.
5. F. Chorlton (2002). *Text Book of Dynamics* 2nd Ed, CBS.
6. F. Gantmacher (1975). *Lectures in Analytic Mechanics*, Mir Publishers.
7. Francis B. Hilderbrand (1992). *Methods of applied mathematics* , Dover Publication.
8. Narayan Chandra Rana&PramodSharad Chandra Joag (1991). *Classical Mechanics*, Tata McGraw Hill.


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DSE-5 Discrete Mathematics

| Session: 2023-24 (Scheme), 2025-26 (Syllabus) | |
|---|---|
| **PartA – Introduction** | |
| Subject | Mathematics |
| Semester | VI |
| Name of the Course | Discrete Mathematics |
| Course Code | B23-MAT-605 |
| CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | DSE |
| Level of the course | 300-399 |
| Pre-requisite for the course (ifany) | Courses on Algebra up to the level 299 |
| CourseLearningOutcomes(CLOs): | After completing this course, the learner will be able to:<br>1. Understand the notion of sets, logical connectives, tautologies, theory of inference, permutations, combinations and discrete probability.<br>2. Have knowledge of relations, lattices, chains and antichains, functions and recursive functions.<br>3. Have deeper knowledge and understanding of discrete numeric functions, generating functions and recurrence relations.<br>4. Understand and solve problems related to lattices and algebraic systems, Boolean algebras, Boolean functions and Boolean expressions. |

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| | |
|---|---|
| CLO 5 is related to the practical component of the course. | 5. Attain cognitive and technical skills required for solving practical problems related to sets, permutations, combinations, relations and Boolean algebra. |

| Credits | Theory | Practical | Total |
|---|---|---|---|
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| Internal Assessment Marks | 20 | 10 | 30 |
| End term Examination Marks | 50 | 20 | 70 |
| Examination Time | 3 Hours | 3 Hours | |

Max. Marks:100

**PartB-Contentsofthe Course**

**Instructions for Paper- Setter**

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Sets, countability and cardinality of sets, principle of inclusion and exclusion, multisets, logical connectives, conditional and biconditionals, tautologies, logical equivalences, inference theory, predicate calculus, Euclidean algorithim, permutations, combinations and discrete probability. | 12 |
| II | Relations, equivalence relations, partial ordering relations and lattices, chains and antichains, functions, composition | 12 |

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| | of functions, invertible functions, recursive functions. | |
| III | Discrete numeric functions, generating functions, combinatorial problems, recurrence relations, linear recurrence relations with constant coefficients, homogeneous solutions, particular solutions, total solutions, solution by method of generating functions. | 12 |
| IV | Lattices and algebraic systems, principle of duality, distributive and complemented lattices, boolean lattices, boolean algebras, uniqueness of finite boolean functions and boolean expressions. | 12 |
| | **Practical** | |
| | The examiner will set 4 questions at the time of practical examination asking two questions by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve two problems. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.<br>**Problem Solving: Questions related to the following problems will be worked out and record of those will be maintained in the Practical Notebook:**<br>1. Use of principle of inclusion and exclusion.<br>2. Checking of equivalence of two propositions.<br>3. The number of ways to choose three out of seven days with repetitions allowed.<br>4. Practical problem based on Bayes' theorem.<br>5. To check that given relation is equivalence relation or not. | 30 |

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| | 6. To check that given relation is partial order or not.<br>7. Practical problems based on composition of functions and invertible functions<br>8. Practical problem to find homogeneous solution of recurrence relations with constant coefficients.<br>9. Find the total solution of the given recurrence relation.<br>10. To find the generating function of the numeric function.<br>11. Practical problem based on principle of duality.<br>12. To check that a given lattice is distributive lattice or not.<br>13. To check that a given lattice is boolean lattice or not. | |

**Suggested Evaluation Methods**

| | |
|---|---|
| **InternalAssessment:**<br>➢ **Theory 20**<br>• Class Participation: 5<br>• Seminar/presentation/assignment/quiz/class test etc.: 5<br>• Mid-Term Exam: 10<br>➢ **Practicum 10**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.: 10<br>• Mid-Term Exam: | **End Term Examination:**<br>➢ **Theory 50**<br>Written Examination<br>➢ **Practicum 20**<br>Lab record, viva-voce, write up and execution of the program |

**PartC-Learning Resources**

**Recommended Books:**


1. C. L. Liu and D. P. Mohapatra (2017). *Elements of Discrete Mathematics* (4th edition). McGraw Hill Education.
2. N. Deo (1979). *Graph Theory*, Prentice Hall of India Pvt. Ltd.
3. S. Lipschutz and M. L. Lipson (2022). *Schaum's Outline of Discrete Mathematics* (4th edition). New York: McGraw Hill.
4. K. H. Rosen (2017). *Discrete Mathematics And its Applications* (7th edition). McGraw Hill Education.


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**DSE-5** Mathematical Modelling

| **Session: 2023-24 (Scheme), 2025-26 (Syllabus)** | |
|---|---|
| **Part A – Introduction** | |
| Subject | Mathematics |
| Semester | VI |
| Name of the Course | Mathematical Modelling |
| Course Code | B23-MAT-606 |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | DSE |
| Level of the course | 300-399 |
| Pre-requisite for the course (if any) | Mathematics as a subject at level 5.0 |
| Course Learning Outcomes (CLOs): | **After completing this course, the learner will be able to:**<br>1. Gain the knowledge and understanding of the underlying principles and theories related to mathematical modelling. Have the knowledge about the current and emerging issues and latest development related to mathematical modelling. Learn to apply the fundamental analytical techniques and simulation methods to develop insight into system behavior.<br>2. Have the procedural knowledge to apply ordinary differential equation concept in solving the real world problems based mathematical models related to population dynamics, epidemic and |

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| | compartment problems.<br>3. Gain the knowledge and understanding to formulate and solve the conceptual mathematical models related to Economics, Medicines, Arms race, Battle, International trade and dynamics problems.<br>4. Have the procedural knowledge to solve the mathematical models related to Population dynamics and Genetics, Growth models, Decay models, Drug delivery problems etc. using difference equations. |
| CLO 5 is related to the practical component of the course. | 5. Attain the cognitive and technical skills required to develop mathematical models of real life and scientific problems and find their solutions using free and open source software tools. |

| Credits | Theory | Practical | Total |
|---|---|---|---|
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| Internal Assessment Marks | 20 | 10 | 30 |
| End Term Examination Marks | 50 | 20 | 70 |
| Examination Time | 3 Hours | 3 Hours | |

Max. Marks: 100

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

**Note:** The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

Unit

1

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| Unit | Topics | Contact Hours |
|---|---|---|
| I | matical modelling definition, Need, Classification, Simple ons requiring mathematical modelling, Techniques of matical modelling, Classification of mathematical models, cteristics of mathematical models, Latest development in matical Modelling, Merits and Demerits of Mathematical ling, Quantitative and Qualitative approach of modelling, ptual and Physical models, Models in real world problem. | 12 |
| II | ematical modelling through ordinary differential equations rst order, Mathematical modelling in population dynamics, ematical modelling of epidemic and compartment models gh system of ordinary differential equations. | 12 |
| III | Mathematical modelling in Economics, Medicines, Arms race, Battle, International trade and dynamics through ordinary differential equations, Mathematical modelling through ordinary differential equation of second order. | 12 |
| IV | Mathematical modelling through difference equation: Need, Basic theory, Economics and Finance, Population dynamics and Genetics, Discrete dynamical systems, Linear models, Growth models, Decay models, Drug delivery problems. | 12 |
| | **Practical** | |
| | This course has programs, based on MATLAB/MATHEMATICA/MAPLE Software, related to Mathematical and scientific models. The examiner will set 4 programs at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to execute two programs. The | 30 |

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evaluation will be done on the basis of practical record, viva-voce, write-up and execution of the program.

**Practicals: The following practicals will be done using the MATLAB/MATHEMATICA/MAPLE Software and record of those will be maintained in the practical Note Book:**

1. Growth model (exponential case only).
2. Decay model (exponential case only).
3. Lake pollution model (with constant/seasonal flow and pollution concentration)
4. Case of single cold pill and a course of cold pills.
5. Limited growth of population (with and without harvesting).
6. Predatory-prey model (basic volterra model, with density dependence, effect of DDT, two prey one predator).
7. Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers).
8. Battle model (basic battle model, jungle warfare, long range weapons).
9. Drug delivery models.
10. Economics Model.

**Suggested Evaluation Methods**

| **Internal Assessment:** | **End Term Examination:** |
|---|---|
| ➢ **Theory 20**<br>• Class Participation: 5<br>• Seminar/presentation/assignment/quiz/class test etc.: 5<br>• Mid-Term Exam: 10<br>➢ **Practical 10**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.: 10<br>Mid-Term Exam: | ➢ **Theory 50**<br>Written Examination<br>➢ **Practical 20**<br>Lab record, viva-voce, write-up and execution of programs |

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## Part C-Learning Resources

**Recommended Books:**


1. J.N. Kapur (2021). *Mathematical Modelling* (2nd Edition). New Age International Pvt. Ltd.
2. B. Barnes and G.R. Fulford (2016). *Mathematical Modelling with Case Studies: Using MAPLE and MATLAB* (3rd Edition). Chapman and Hall/CRC.
3. L. Edsberg (2008). *Introduction to Computation and Modeling for Differential Equations*. Wiley.
4. F.R. Marotto (2005). *Introduction to Mathematical Modeling using Discrete Dynamical Systems*. Thomson Brooks/Cole.
5. C.L. Dym (2004). *Principles of Mathematical Modeling*(2nd Edition). Academic Press.
6. E.A. Bender (2003). *An Introduction to Mathematical Modeling*. Dover Publications.
7. G. Fulford, P. Forrester and A. Jones (1997). *Modelling with Differential and Difference Equations*. Cambridge University Press.


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## SEC-4 Basic Mathematical Techniques

| Session: 2023-24 (Scheme), 2025-26 (Syllabus) | |
|---|---|
| **PartA - Introduction** | |
| Subject | Mathematics |
| Semester | VI |
| Name of the Course | Basic Mathematical Techniques |
| Course Code | B23-SEC-406 |
| CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | SEC |
| Level of the course | 200-299 |
| Pre-requisite for the course (ifany) | |

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| CourseLearningOutcomes(CLO): | **After completing this course, the learner will be able to:**<br>1. Attain theoretical knowledge of Eigen values and Eigenvectors, Geometric and Algebraic multiplicity, Characteristic equation and matrix polynomial.<br>2. Understand theoretical concepts of numerical methods for solving algebraic and transcendental equations and attain practical skills for their implementation.<br>3. Gain deep theoretical knowledge of techniques of solving differential equations and technical skills to implement these techniques of realistic problems which arise in all disciplines.<br>4. Understand theoretical concepts of statistical techniques and attain practical skills for their implementation. |
| CLO 5 is related to practical component of the course. | 5.Gain hand on experience of implementation of basic mathematical techniques for solving practical problems on paper and through either of listed softwares. |

| | Theory | Practical | Total |
|---|---|---|---|
| Credits | 1 | 1 | 2 |
| Contact Hours | 1 | 2 | 3 |
| Internal Assessment Marks | 10 | 5 | 15 |
| End Term Examination Marks | 20 | 15 | 35 |
| Examination Time | 3 Hours | 3 Hours | |

Max. Marks: 50

**Part B-Contents of the Course**

**Instructions for Paper- Setter**

**Note:** The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 4 parts covering entire syllabus. The examinee will be required to

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attempt 5 questions, selecting one question from each unitand the compulsory question.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Definition of Eigen values and Eigenvectors, Geometric and Algebraic multiplicity, Characteristic equation and matrix polynomial .Basic algorithm of the Power Method Convergence criteria Inverse Power Method, Shifted Power Method. | 4 |
| II | Techniques for solving algebraic and transcendental equations: Newton-Raphson, Chebyshev, derivative free, iterative, Bairstow. | 4 |
| III | Numerical techniques for solving ODEs: Euler methods, Runge-Kutta methods (2nd and $4^{th}$ order), Nystrom method, Adams-Bashforth method.<br>Taylor series method and Runge-Kutta methods for solving system of differential equations. | 4 |
| IV | Statistical hypothesis test, t-test for one and two samples, F-test, chi-square test, Statistical methods for data fitting: Linear, multi-linear, non-linear regression. | 4 |
| | Practical | |
| | The practical component of the course involvesproblem solving using MAXIMA/Scilab/SageMath/SPSS software. The examiner will set 4 programs at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to execute two programs. The evaluation will be done on the basis of practical record, viva-voce, write-up and execution of the program.<br>Practicals related to the following problems will be solved using | 30 |

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|---|---|---|
| | MAXIMA/Scilab/SageMathsoftwares and record of those will be maintained in the practical note book:<br>1. Problems based on analytical techniques to solve Eigen values and Eigenvectors.<br>2. Problems involving numerical techniques to solve Characteristic equation and matrix polynomial.<br>3. Problems solving by Newton-Raphson method.<br>4. Problems solving by Chebyshev and Bairstow methods.<br>5. Solving differential equations by Euler method .<br>6. Problems solving of differential equations by Runge-Kutta methods.<br>7. Problems solving by Adams-Bashforth method.<br>8. Problems solving for linear homogeneous system of differential equations.<br>9. To apply t -test for testing single mean and difference between means and to obtain their confidence intervals.<br>10. To apply paired t-test for difference between two means.<br>11. To apply Chi- square test for goodness of fit.<br>12. To apply Chi- square test for independence of attributes. | |

**Suggested Evaluation Methods**

| | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory**<br>• Class Participation: 4<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam: 6<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.: 5<br>• Mid-Term Exam: | **End Term Examination:**<br>➢ **Theory 20**<br>Written Examination<br>➢ **Practicum 15**<br>Lab record, viva-voce, write-up and execution of programs. |

**Part C-Learning Resources**

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**Recommended Books/e-resources/LMS:**


1. Gupta, R.K. (2019) *Numerical Methods: Fundamentals and Applications* Cambridge University Press.
2. M.K. Jain, S.R.K. Iyengar& R.K. Jain (2020). *Numerical Methods: Problems and Solutions* (3rd Edition). New Age International Publishers.
3. S.S. Sastry (2012). *Introductory Methods of Numerical Analysis* (5th Edition).Prentice Hall India Learning Private Limited.
4. P. Kandasamy, K. Thilagavathy, K. Gunavathi (2006). *Numerical Methods*. S. Chand & Company.
5. E.Balagurusamy (2017). *Numerical Methods*. McGraw Hill Education.


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# DEPARTMENT OF MATHEMATICS
# CHAUDHARY RANBIR SINGH UNIVERSITY

| Session: 2025-26 | |
|---|---|
| **Part A - Introduction** | |
| Subject | Mathematics |
| Semester | V |
| Name of the Course | Reasoning |
| Course Code | B23-MAT-507 |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/SEC/VAC) | VOC |
| Level of the course | 100-199 |
| Pre-requisite for the course (if any) | NA |
| Course Learning Outcomes(CLO):<br><br>CLO 5 is related to the practical components of the course. | **After completing this course, the learner will be able to:**<br>1. Gain the skill to analyze and solve letter and number series and to pick odd one out.<br>2. Understand the concept of coding and decoding. To find the directions and blood relations from the situations.<br>3. Familiarize and get acquainted with arithmetic reasoning and venn diagrams.<br>4. Have the knowledge of obtaining water and mirror images and find analogy between words, numbers and figures.<br>5. Attain the cognitive and technical skills to use analytical reasoning for solving series, words relationship and pattern problems. |

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| Credits | Theory | Practical | Total |
|---|---|---|---|
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| Internal Assessment Marks | 20 | 10 | 30 |
| External Assessment Marks | 50 | 20 | 70 |
| Examination Time | 3Hrs | 3Hrs | |

Max. Marks:100

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

**Theory Paper:** The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Verbal Reasoning: Series Completion, Number series, Letter Series, Alpha numeric series, Wrong Letter Series, Repeat Series, Wrong Number Series, Number Analogy, Word Analogy. | 12 |
| II | Coding and Decoding: Letter Coding, Number coding, Matrix coding, Place arrangement, Direction sense, Family-based puzzles; Blood Relationships. | 12 |
| III | Arithmetic reasoning, Venn diagrams, Logical diagrams, Symbol Substitution. | 12 |
| IV | Non-verbal Reasoning: Choosing the odd figure, Word Analogy, Number Analogy, Water Images, Mirror Images. | 12 |

**Practical**

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| | | |
|---|---|---|
| | The examiner will set 4 questions at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve 2 questions. The evaluation will be done on the basis of practical | 30 |
| | record, viva-voce, written examination.<br>**Problem Solving: Questions related to the following problems will be solved and record of those will be maintained in the Practical Note Book:**<br><br>1. Determination of order of the letters or number in the series.<br>2. Identification of letter or number which is wrong or misfit in the series.<br>3. Find out the repeated letter group series.<br>4. Spotting the odd one out.<br>5. Coding with letters of alphabets.<br>6. Mixed coding (both alphabetical and numerical).<br>7. Depicting the correct direction.<br>8. Studying the relationship mentioned between the persons and selecting the right relationship.<br>9. Identification of the most appropriate venn diagram for the given problem.<br>10. To obtain the water images of figures.<br>11. To obtain the mirror images of figures.<br>12. Finding relationship between words using analogy.<br>13. Finding relationship between numbers using analogy.<br>14.Finding relationship between figures using non-verbal analogy. | |
| **Suggested Evaluation Methods** | | |

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| Internal Assessment: | End Term Examination: |
|---|---|
| ➢ **Theory :20**<br>• Class Participation: 5<br>• Seminar/presentation/assignment/quiz/class test etc.: 5<br>• Mid-Term Exam: 10<br>➢ **Practicum :10**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.: 10<br>• Mid-Term Exam: | **Theory 50**<br>Written Examination<br>**Practicum 20**<br>Lab record, viva-voce, written examination. |

## Part C-Learning Resources

**Recommended Books:**


1. Edgor Thorpe (2018). *A course in mental ability and Quantitative aptitude* (4th edition). Tata McGraw Hill Company, New Delhi.
2. Ravi Chopra (2006). *Logical Critical Analytical Reasoning* (1st edition). Galgotia Publications Pvt. Ltd., New Delhi.
3. R.S. Aggarwal (2018). *A Modern approach to Verbal and Non-verbal reasoning* (2nd edition). S.Chand and Company Ltd., New Delhi.
4. N.K. Sinha (2019). *Reasoning: Verbal, Non-verbal & Analytical* (1st edition). Pearson Education, New Delhi.
5. M.K. Pandey (2009). *Analytical Reasoning* (3rd edition). BSC Pvt. Ltd., Pune, Maharashtra.


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# DEPARTMENT OF MATHEMATICS
# CHAUDHARY RANBIR SINGH UNIVERSITY

| Session: 2025-26 | | | |
|---|---|---|---|
| **Part A - Introduction** | | | |
| Subject | Mathematics | | |
| Semester | VI | | |
| Name of the Course | Mathematical Explorations in Numbers and Shapes | | |
| Course Code | B23-MAT-607 | | |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/SEC/VAC) | VOC | | |
| Level of the course | 100-199 | | |
| Pre-requisite for the course (if any) | NA | | |
| Course Learning Outcomes(CLO):<br><br>CLO 5 is related to the practical components of the course. | **After completing this course, the learner will be able to:**<br>1. Understand foundational concepts of numbers, including number types and their properties.<br>2. Apply coordinate geometry to interpret positions and distances in space.<br>3. Apply modular arithmetic, divisibility rules, and check-digit systems in real-life problems.<br>4. Understand basic geometric shapes and their properties, and use geometry to analyze real-world objects.<br>5. Use tools and technology to explore mathematical concepts. | | |
| Credits | Theory | Practical | Total |

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| | | | |
|---|---|---|---|
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| Internal Assessment Marks | 20 | 10 | 30 |
| External Assessment Marks | 50 | 20 | 70 |
| Examination Time | 3Hrs | 3Hrs | |

Max. Marks:100

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

**Theory Paper:** The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Number Systems and Basic Geometry: Natural numbers, integers, rational and irrational numbers, real numbers, number line, properties of operations, basic shapes (points, lines, angles, triangles, polygons, circles). | 12 |
| II | Prime numbers, HCF, LCM, divisibility rules, Euclidean algorithm, Fibonacci sequence, perfect and amicable numbers, magic squares, tessellations, geometric patterns, congruence, similarity. | 12 |
| III | Modular arithmetic, congruences, digital roots, casting out nines, coordinate geometry (distance formula, slope, section formula, symmetry, transformations, map and layout applications). | 12 |
| IV | Surface area and volume of solids (cube, cylinder, cone, sphere, cuboid), real-life applications (packaging, architecture), check-digit systems (ISBN, credit card), mathematical games and puzzles. | 12 |
| **Practical** | | |

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| | | |
|---|---|---|
| | The examiner will set 4 questions at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve 2 questions. The evaluation will be done on the basis of practical record, viva-voce, written examination.<br><br>**Problem Solving: Questions related to the following problems will be solved and record of those will be maintained in the Practical Note Book:**<br><br>1. Test properties of integers and basic operations.<br>2. Apply factorization, primality tests, HCF/LCM rules.<br>3. Use modular arithmetic in logic puzzles.<br>4. Explore number patterns and solve magic square problems.<br>5. Measure geometric shapes and estimate real-life volumes and areas.<br>6. Solve real-world puzzles (calendar, barcodes, check digits).<br>7. Visualize number sequences (Fibonacci, prime distributions).<br>8. Simulate modular arithmetic operations.<br>9. Create and analyze floor plans and geometric designs.<br>10. Simulate geometric transformations and symmetry. | 30 |

**Suggested Evaluation Methods**

| | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory :20**<br>• Class Participation: 5<br>• Seminar/presentation/assignment/quiz/class test etc.: 5<br>• Mid-Term Exam: 10<br>➢ **Practicum :10**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.: 10<br>• Mid-Term Exam: | **End Term Examination:**<br>□ **Theory 50**<br>Written Examination<br>□ **Practicum 20**<br>Lab record, viva-voce, written examination. |

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## Part C-Learning Resources

**Recommended Books:**


1. Martin Gardner (1956). *Mathematical Puzzles and Diversions*, Penguin Books.
2. David Wells (1986). *The Penguin Dictionary of Curious and Interesting Numbers*, Penguin Books.
3. George E. Andrews (1994). *Number Theory*, Dover Publications.
4. Richard E. Klima & Neil Sigmon (2006). *Applications of Abstract Algebra with Maple*, CRC Press.
5. Ivan Niven, H.S. Zuckerman, H.L. Montgomery (1991). *An Introduction to the Theory of Numbers*, Wiley (5th Ed.).
6. R.D. Sharma (2024). *Mathematics for Class 10 and 12 – Geometry Sections*, Dhanpat Rai Publications.
7. George W. Hart (2011). *Mathematical Impressions: Geometry in Art*, MAA.
8. Michael Serra (2008). *Discovering Geometry: An Investigative Approach*, Kendall Hunt Publishing.


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