**Chaudhary Charan Singh University, Meerut**


**Structure and Syllabus**
**for**
**First Two Years (I to IV Semesters)**
**of**
**B.Sc. Honours/ Honours with Research in Mathematics (University Campus)**
**(A Four-Year Degree Program with Multiple Exits and Entries)**
**(National Education Policy-2020)**

**May, 2024**

**Eligibility:**

Students of 10+2 ($12^{th}$) with Mathematics

**Subject Prerequisites:**

To study this subject, a student must have passed $12^{th}$ class with Mathematics.

**Programme Outcomes (POs):**

Students having Degree in B.Sc. Honours (Mathematics) should have knowledge of different concepts and fundamentals of Mathematics and ability to apply this knowledge in various fields of industry. They may pursue their future career in the field of Mathematics and Research.

**Programme Specific Outcomes (PSOs):**

After completing B.Sc. Honours (Mathematics) the student will have

| | |
|---|---|
| PSO 1 | **Disciplinary Knowledge:** Bachelor degree in Mathematics is the culmination of in-depth knowledge of Algebra, Calculus, differential equations and several other branches of pure and applied mathematics. This also leads to study the related areas such as computerscience and other allied subjects. |
| PSO 2 | **Communication Skills**: Ability to communicate various mathematical concepts effectively using examples and their geometrical visualization.The skills and knowledge gained in this program will lead to the proficiency in analytical reasoning which can be used for modelingand solving of reallife problems. The completion of this programme will enable the learner to use appropriate softwares to solve system of algebraic equation and differential equations |
| PSO 3 | **Critical Thinking and Analytical Reasoning:** The students undergoing this programme acquire ability of critical thinking and logical reasoning and capability of recognizing and distinguishing the various aspects of real-life problems. |
| PSO 4 | **Research Related Skills & Problem Solving Skills**: The Mathematical knowledge gained by the students through this programme develop an ability to analyze the problems, identify and define appropriate computing requirements forits solutions. This programme enhances students overall development and also equip them with mathematical modeling ability, problem solving skills. The completing this programme develop thecapability of inquiring about appropriate questions relating to the Mathematical concepts in different areas of Mathematics. |
| PSO 5 | **Moral and Ethical Awareness/Reasoning:** The student completing thisprogram will develop an ability to identify unethical behavior such as fabrication, falsification or misinterpretation of data and adopting objectives, unbiased and truthful actions in all aspects of life in general and mathematical studies in particular. |
| PSO 6 | **Lifelong Learning Skills**: This programme provides self-directed learning and lifelong learning skills. This programme helps the learner to think independently and develop algorithms and computational skills for solving real word problems. |

**B.Sc. Honours/ Honours with Research (Mathematics)**
**A Four-Year Degree Program with Multiple Exits and Entries**
**Semester-wise Course Structure and Credits**

| Year | Sem. | Course Code | MJCC/ MJEC/ MNGEC/AEC/ SEC/VAC | Paper Title | Credits L-T-P | Total Credits |
|---|---|---|---|---|---|---|
| I | I | | MJCC I | Algebra | 4-0-0 | 4 |
| | | | MJCC II | Analysis-I | 4-0-0 | 4 |
| | | | MJCC III | Differential Calculus | 4-0-0 | 4 |
| | | | MNGEC(for students of other disciplines) | 1.Computer Fundamentals and Programming in C<br>2. Differential Calculus | 4-0-0 | 4 |
| | | | AEC I | From the Pool of Courses offered by the University | 2 | 2 |
| | | | SEC I | Mathematical Typesetting with LaTeX | 1-0-1 | 2 |
| | | | VAC I | Vedic Ankganit | 2-0-0 | 2 |
| | | | | | | |
| | II | | MJCC IV | Group Theory | 4-0-0 | 4 |
| | | | MJCC V | Geometry & Vectors | 4-0-0 | 4 |
| | | | MJCC VI | Ordinary Differential Equations | 4-0-0 | 4 |
| | | | MNGEC (for students of other disciplines) | 1.Matrix Theory<br>2. Ordinary Differential Equations | 4-0-0 | |
| | | | AEC II | From the Pool of Courses offered by the University | 2 | 2 |
| | | | SEC II | Mathematica | 1-0-1 | 2 |
| | | | VAC II (From MOOCS) | Any one of the following:<br>1. Logic & Sets<br>2. Effective Decision Making | | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | 3. Human Growth & Development | | |
| | | | | | | |
| II | III | | MJCC VII | Ring Theory | 4-0-0 | 4 |
| | | | MJCC VIII | Integral Calculus | 4-0-0 | 4 |
| | | | MJCC IX | Discrete Mathematics | 4-0-0 | 4 |
| | | | MJEC | Any one of the following (MJEC)<br>1.Elementary Number Theory & Cryptography<br>2.Integral Transform<br>3. Computer Fundamentals and Programming in C | 4-0-0 | 4 |
| | | | MNGEC(for students of other disciplines) | Real Analysis | 4-0-0 | 4 |
| | | | AEC III | From the Pool Courses offered by the University | 2 | 2 |
| | | | SEC III | MATLAB for Beginners | 1-0-1 | 2 |
| | | | | | | |
| | IV | | MJCC X | Analysis-II | 4-0-0 | 4 |
| | | | MJCC XI | Mechanics | 4-0-0 | 4 |
| | | | MJCC XII | Numerical Analysis | 4-0-0 | 4 |
| | | | MJEC | Any one of the following [MJEC]<br>1.Linear Programming and Applications<br>2.Introduction to Fuzzy Sets | 4-0-0 | 4 |
| | | | MNGEC(for students of other disciplines) | Numerical Methods | 4-0-0 | 4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | AEC IV | From the Pool of Courses offered by the University | | 2 |
| | | | SEC IV | Computer Algebra System | 1-0-1 | 2 |
| | | | VAC III (From MOOCS) | Any one of the following:<br>1. Research and Publication ethics<br>2. Research ethics & Plagiarism<br>3. Entrepreneurship management | | 2 |

Note: VIAPCW of **4 credits** after semester II for certificate/ II or IV for diploma/ II or IV or VI for Degree is mandatory.

Nomenclature:

MJCC: Major Core Course
MJEC: Major Elective Course
MNGEC: Minor Generic Elective Course
AEC: Ability Enhancement Course
SEC: Skill Enhancement Course
VAC: Value Addition Course
VIAPCW: Vocational Course/ Internship/ Apprenticeship/ Project/ Community Outreach/ Workshop
L: Lecture, T: Tutorial, P: Practical or Practice

(Prof. Jaimala) (Prof. M. K. Gupta) (Prof. Shivraj Singh)

(Prof. Mukesh Kumar Sharma) (Prof. A. B. chandramouli) (Prof. A. K. Bhargava)

(Dr. Madan Pal Singh) (Prof. R. C. Dimri) online (Prof. S. P. Sharma) online

(Prof. D. Pandey) (Dr. V. K. Agarwal)

**B.Sc. Honours/ Honours with Research (Mathematics)**
**A Four-Year Degree Program with Multiple Exits and Entries**
**Semester-wise Syllabus**

| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: First** | **Semester: First** |
| Course Code: | Course Type: MJCC-I |
| Core: **Compulsory** | Course Title: Algebra |
| Credits (in hours per week):4 | 3L-1T-0P |
| Internal Assessment : 30% | External Assessment : 70% |

**Course Outcomes:**

This course will enable the students to:

- ✓ own necessary prerequisites and build substantial foundation for grasping abstract algebra and linear algebra.
- ✓ introduce at groups, their basic concepts, types, examples, and properties.
- ✓ learn various methods to determine the rank of a matrix.
- ✓ recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix. find eigenvalues and corresponding eigenvectors for a square matrix.

| Unit | Topics | No. of Hours |
|---|---|---|
| I | Sets, Product of sets, Functions, Binary operation, Relations, Equivalence Relations, Partitions, Partial order relations, Residue classes of the set of integers, Permutations, Cyclic Permutations, Even and odd permutations. | 15 |
| II | Binary operation on a set, Algebraic structure, Group, Abelian group, Quaternion group, Order of a finite group, Groups of Permutations, Alternating group, Integral powers of an element of a group, Order of an element of a group, Group homomorphism, Group Isomorphism, The relation of isomorphism in the set of all group, Cayley's theorem. | 15 |
| III | Rank of a Matrix, System of linear homogeneous and non-homogeneous equations, Theorems on consistency of a system of linear equations. Echelon form of a Matrix, Normal form of a Matrix, Inverse of a Matrix by elementary operations. | 15 |
| IV | Eigen values, Eigen vectors and characteristic equation of a matrix, Caley-Hamilton theorem and its applications in finding inverse of a matrix, Diagonalization of matrices. | 15 |

**Essential/ Recommended Readings:**

1. I. N. Herstein, Topics in Algebra, John Wiley & Sons, 2006
2. Joseph A Gallian, Contemporary Abstract Algebra, Brooks/Cole Cengage Learning, 2016
3. Shanti Narayan and Dr. P.K. Mittal, A Textbook of Matrices, S Chand & Company, 2010.
4. J.B. Fraleigh, A first course in Abstract Algebra, Addison-Wiley, 2003

| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: First** | **Semester: First** |
| Course Code: | Course Type: MJCC-II |
| Core: **Compulsory** | Course Title: Analysis-I |
| Credits (in hours per week): 4 | 3L-1T-0P |
| Internal Assessment: 30% | External Assessment: 70% |

**Course Outcomes:**

After completing this course:

- ✓ Students will acquire a thorough understanding of the fundamental properties of the real number line (R), including completeness and order structure.
- ✓ students will be able to analyze the behavior of sequences of real numbers using convergence criteria and determine their convergence or divergence.
- ✓ Students will develop the ability to construct rigorous mathematical proofs to establish the convergence properties of sequences and series of real numbers.
- ✓ students will possess the foundational knowledge necessary to comprehend and engage with advanced topics in mathematics.

| Unit | Topics | No. of Hours |
|---|---|---|
| I | **Real Number System R:** The field and order axioms of real numbers, intervals, the unique factorization theorem for integers, upper bounds, maximum element, least upper bound (supremum), lower bounds, minimum element, greatest lower bound (infimum), the completeness axiom of real numbers, some properties of supremum and infimum, properties of integers deduced from the completeness axiom, the Archimedean property of the real number system, absolute values and the triangle inequality, the Cauchy-Schwarz inequality. | 15 |
| II | **Basic Properties of R:** Neighborhood, the structure of open sets in R, interior point, isolated point, closed set, Adherent point, Accumulation point, interior of a set, closure of a set in real numbers and their properties, Bolzano-Weiestrass theorem, Heine-Borel covering theorem. | 15 |
| III | **Sequence:** Real sequence and its convergence, theorems on limits of sequence, bounded and monotonic sequences, limit superior and limit inferior for bounded sequence, Cauchy's sequence, Cauchy general | 15 |

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|---|---|---|
| | principle of convergence, subsequences, Bolzano-Weierstrass theorem for sequences. | |
| IV | **Infinite series:** Convergence and divergence of infinite series, the necessary condition for convergence of an infinite series with positive terms (ISPT), Cauchy' s general principle of convergence of series, convergence and divergence of geometric series, convergence of ISPT: Comparison test. D-Alembert's ratio test, Raabe's test, Logarithmic test, De Morgan and Bertrand's test, Cauchy's nth root test, Gauss Test, Cauchy's integral test, Cauchy's condensation test, alternating series, Leibnitz's test, absolute and conditional convergence. | 15 |

**Essential/ Recommended Readings:**


1. S. C. Malik, S. Arora (2018): Mathematical Analysis, New Age Publications.
2. R. G, Bartle, D. R. Sherbert (2015): Introduction to Real Analysis (4th ed.). Wiley India Edition. New Delhi.
3. Stephen, Abbott (2015): Understanding analysis. Springer.


| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: First** | **Semester: First** |
| Course Code: | Course Type: MJCC-III |
| Core: **Compulsory** | Course Title: Differential Calculus |
| Credits (in hours per week): 4 | 3L-1T-0P |
| Internal Assessment : 30% | External Assessment : 70% |

**Course Objectives:** The primary objective of this course is to introduce the basic tools of calculus, also known as "science of variation", which provides a way of viewing and analyzing the real-world.

**Course Outcomes: Through this course of Differential Calculus, students will**

- ✓ Understand the concept of limits, continuity and uniform continuity, indeterminate form of functions.
- ✓ Understand continuity and differentiability in terms of limits and obtain successive differentiation and expansion of functions, derivation and applications of Rolle's theorem and mean value theorem.
- ✓ Apply the concepts of asymptotes, inflexion points, position, and nature of double points in tracing of Cartesian curves as well as parametric and polar curves. Learn to expand the function using Taylor's series.
- ✓ Be familiar with the concepts of limit, continuity and partial derivatives of functions of two variables. Understand the use of derivatives to explore the behaviour of a given function in locating and classifying its extrema. Learn to find tangents, normal, radius of curvature, envelops and evolutes.

| Unit | Topics | No. of Hours |
|---|---|---|
| I | **Limits and Continuity**<br>Limits of functions ($\varepsilon - \delta$ and sequential approach), Uniqueness theorem on limits, Algebra of limits, Indeterminate forms, L' Hôpital's rule, Continuous functions and classification of discontinuities, Uniform continuity, Basic properties of continuous and uniformly continuous functions | 15 |
| II | **Differentiability and Mean Value Theorems**<br>Differentiability of a real-valued function, Chain rule of differentiability, Algebra of differentiable functions, Rolle's theorem, Mean-value theorems and their applications, Intermediate value theorem for derivatives, Maxima and Minima for a single variable function on R. | 15 |
| III | **Successive Differentiation, Taylor's Theorem and Tracing of Plane Curves**<br>Higher order derivatives and calculation of the *n*th derivative, Leibnitz's theorem; Taylor's theorem, Taylor's series expansions of sin x, cos x, $e^x$, log x, and $a^x$, Concavity, and inflexion points; Singular points, Asymptotes, Tracing of graphs of rational functions. | 15 |
| IV | **Tangent,Normals and Curvature**<br>Tangents and normals, Cartesian and polar subtangent and subnormal, Intercepts, Length of the tangent and normal, Length of the perpendicular from the pole on tangent, Pedal equation of the curve, Curvature, Cartesian, polar and parametric formulae for radius of curvature, Envelopes and evolutes. | 15 |

**Recommended Readings:**


1. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). *Calculus* (10th ed.). John Wiley & Sons Singapore Pvt. Ltd. Reprint (2016) by Wiley India Pvt. Ltd. Delhi.
2. Bartle, Robert G., & Sherbert, Donald R. (2011). *Introduction to Real Analysis* (4th ed.). John Wiley & Sons. Wiley India Edition 2015.
3. Prasad, Gorakh (2016). *Differential Calculus* (19th ed.). Pothishala Pvt. Ltd. Allahabad.
4. Ross, Kenneth A. (2013). *Elementary Analysis*: *The Theory of Calculus* (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian reprint.
5.G.B. Thomas and R.L. Finney (2007) : Calculus, Pearson Education
6.Shanti Narayan (2005): Differential Calculus, S.Chand, New Delhi
7. Win Kreyszig, (2011): Advanced Engineering Mathematics, John Wiley & Sons.
8. Mukesh Kumar, A. P. Singh and Ashok Kumar (2018) Differential Calculus Medtech
9. Suggested digital platform: NPTEL/SWAYAM/MOOCS.


| Program: **B.Sc. (Honours/ Honours** | Subject: Mathematics |
|---|---|

| with Research) | |
|---|---|
| **Year: First** | **Semester: First** |
| Course Code: | Course Type: (Minor) MNGE-I |
| Course Type: Elective | Course Title: **Computer Fundamentals and Programming in C Language** |
| Credits (in hours per week): 4 | 3L-1T-0P |
| Assessment: | |

**Course Outcomes:**

After completing this course, a student will have:

- ✓ Knowledge of computer architecture.
- ✓ An ability to operate computer systems.
- ✓ An ability to analyse a real-world problem and develop an algorithm.
- ✓ An ability to write computer software programs in C language. An ability to write C programs to compute statistical measures.

| Unit | Topic | No. of Lectures |
|---|---|---|
| I | **Basic Computer Structure:** Overview Of Computer System, Memory, C.P.U, I/O Units, Higher and Lower Levels Computer Languages. Basic Concepts of Computer Softwares, Compilers, Operating Systems and Statistical Software packages. Number systems (Binary, Octal, Hexadecimal Systems). | **15** |
| II | **Programming Methods:** Problem analysis, Algorithms, Flow charts, Programming designs, Criteria for a good programming method. | **10** |
| III | **C Programming Language:** Basic features of C Language, Constants, Variables and data types, Operators and expressions: arithmetic, relational and logical, Input and output statements with their formats, Decision making statements, Branching and looping, Arrays, User and system defined functions, Structures and pointers. | **20** |
| IV | C Language Programs for statistical methods such as Measures of central tendency, Dispersion and Moments. | **15** |

**Suggested Readings:**


Balagurusamy E. (1998). Programming in ANSI C, Tata Mc-Graw Hill Publishing company, Ltd. New Delhi.

Kanetkar Yashwant P. (1999). Let us C , BPB Publications, New Delhi.

Kernighan B.W and Ritchie Dennis M. (1997). The C Programming Language, Prentice Hall of India Pvt Ltd. New Delhi.

Raja Raman V. (1999). Computer Programming In C, Prentice Hall of India Pvt. Ltd. New Delhi.

Byron S. (1999). Programming with C, (Schaum's Outline) Tata Mc Graw Hill Publishing Company Ltd. New Delhi

deep K. Sinha, Priti Sinha (2020). Computer Fundamentals. BPB Publications, India.

| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: First** | **Semester: First** |
| Course Code: | Course Type: (Minor) MNGEC II |
| Course Type: Electivefor | Course Title: Differential Calculus |
| Credits (in hours per week): 4 | 3L-1T-0P |
| Assessment: | |

**Course Objectives:** The primary objective of this course is to introduce the basic tools of calculus, also known as "science of variation", which provides a way of viewing and analyzing the real-world.

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**Course Outcomes: After completion of the course, students will**

- ✓ Understand the concept of limits, continuity,uniform continuity, and indeterminate form of functions.
- ✓ Understand continuity and differentiability in terms of limits and obtain successive differentiation and expansion of functions, derivation and applications of Rolle's theorem and mean value theorem.
- ✓ Apply the concepts of asymptotes, inflexion points, position and nature of double points in tracing of Cartesian curves as well as parametric and polar curves.Learn to expand the function using Taylor's series.
- ✓ Understand the use of derivatives to explore the behaviour of a given function in locating and classifying its extrema. Learn to find tangents, normal, radius of curvature, envelops and evolutes.

| Unit | Topics | No. of Hours |
|---|---|---|
| I | **Limits and Continuity**<br>Limits of functions ($\varepsilon - \delta$ and sequential approach), Uniqueness theorem on limits, Algebra of limits, Indeterminate forms, L' Hôpital's rule, Continuous functions and classification of discontinuities, Uniform continuity, Basic Properties of continuous and uniformly continuous functions. | 15 |
| II | **Differentiability and Mean Value Theorems**<br>Differentiability of a real-valued function, Chain rule of differentiability, Algebra of differentiable functions, Rolle's theorem andMean-value theorem and their applications, Intermediate value theorem for derivatives, Maxima and Minima for a single variable function on R. | 15 |
| III | **Successive Differentiation, Taylor's Theorem and Tracing of Plane Curves**<br>Higher order derivatives and calculation of the *n*th derivative, Leibnitz's | 15 |

| | | |
|---|---|---|
| | theorem; Taylor's theorem, Taylor's series expansions of sin x, cos x, $e^x$, log x, and $a^x$, Concavity and inflexion points; Singular points, Asymptotes, Tracing of graphs of rational functions. | |
| IV | **Tangents and Normals, Curvature**<br>Tangents and normals, Cartesian and polar subtangent and subnormal, Intercepts, Length of the tangent and normal, Length of the perpendicular from the pole on tangent, Pedal equation of the curve, Curvature, Cartesian, polar and parametric formulae for radius of curvature, Envelopes and Evolutes. | 15 |

**Recommended Readings:**


1. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). *Calculus* (10th ed.). John Wiley & Sons Singapore Pvt. Ltd. Reprint (2016) by Wiley India Pvt. Ltd. Delhi.
2. Bartle, Robert G., & Sherbert, Donald R. (2011). *Introduction to Real Analysis* (4th ed.). John Wiley & Sons. Wiley India Edition 2015.
3. Prasad, Gorakh (2016). *Differential Calculus* (19th ed.). Pothishala Pvt. Ltd. Allahabad.
4. Ross, Kenneth A. (2013). *Elementary Analysis*: *The Theory of Calculus* (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian reprint.
5.G.B. Thomas and R.L. Finney (2007) : Calculus, Pearson Education
6.Shanti Narayan (2005): Differential Calculus, S. Chand, New Delhi
7. Win Kreyszig, (2011): Advanced Engineering Mathematics, John Wiley & Sons.
8. Mukesh Kumar, A. P. Singh and Ashok Kumar (2018) Differential Calculus Medtech
9. Suggested digital platform: NPTEL/SWAYAM/MOOCS.


| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: First** | **Semester: First** |
| Course Code: | Course Type: SEC-I |
| Core: **Compulsory** | Course Title: Mathematical Typesetting with LaTeX |
| Credits (in hours per week): 2 | 1L-0T-1P |
| Assessment | |

**Course Objectives:**

- ✓ Equip students with the skills to create, format, and design structured and visually appealing LaTeX documents. Enable students to proficiently typeset complex mathematical expressions and structures, ensuring clarity and precision in technical and scientific

documentation.

**Course Outcomes:**

- ✓ Gain proficiency in creating and typesetting simple LaTeX documents.
- ✓ Develop advanced skills in mathematical typesetting.
- ✓ Learn to include and customize images and tables within LaTeX..
- ✓ Efficiently number, reference, and format equations and piecewise functions in LaTeX.

| Unit | Topics | No. of Hours |
|---|---|---|
| I | **Getting Started with LateX:** Introduction to TeX and LaTeX, Formatting text and understanding LaTeX commands and environments, Creating and typesetting a simple LaTeX document, Designing pages, Creating a book with chapters and table of contents, Creating and customizing lists, Including images, and creating tables with captions. | 15 |
| II | **Mathematical Typesetting:** Accents and symbols, Mathematical typesetting (elementary and advanced): Subscript/ Superscript, Roots, Ellipsis, Mathematical Symbols, Arrays, Delimiters, Multiline formulas, Putting one thing above another, Spacing and changing style in math mode, Fractions, Typesetting metrics and determinants, Piecewise function formatting, Numbering equations and referencing, Picture and graphics in LateX. | 15 |

**Essential/ Recommended Readings:**


- Lamport, Leslie (1994). LaTeX: A Document Preparation System, User's Guide and Reference Manual (2nd ed.) Pearson Education. Indian Reprint.
- Kittwitz, Stefan (2021). Latex Beginner's Guide (2nd ed.) Packet Publishing Ltd.
- Binder, Donald & Erickson, Martin. (2011). A Student's Guide to the Study, Practice, and Tools of Modern Mathematics. CRC Press, Taylor & Francis Group, LLC.


| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: First** | **Semester: First** |
| Course Code: | Course Type: VAC-I |
| Core: **Compulsory (Elective)** | Course Title: Vedic Ankganit |
| Credits (in hours per week): 2 | 2L-0T-0P |

| Assessment | |
|---|---|

**Course Objectives:**

- ✓ Foster love for mathematics and promote joyful learning of mathematics through Vedic Mathematics. Enhance computation skills in students through Vedic Mathematics. Develop logical and analytical thinking, Discuss the rich heritage of mathematical temper of Ancient India.

**Course Outcomes: On completion of the course, student will be able to**

- ✓ Understand the concept of high-speed addition, subtraction.
- ✓ Apply the sutras and up sutras to find the multiplication and division.
- ✓ Analyze the various sutras for finding the squares and cubes of numbers
- ✓ Evaluate the quadratic equation by Anurupyena, Adyamadyenantyamanty Sutra. Apply vedic knowledge to deal with matrices, find its determinant and inverse.

| Unit | Topics | No. of Hours |
|---|---|---|
| I | Addition in Vedic Maths- without carrying and dot method, Subtraction in vedic Maths- Nikhilam Navatascaramam Dashatah, vinculum number, Multiplication in vedic Maths- Base method (any two number up to three digits), Urdhva tiryak sutra, Miracle Multiplication- any three digit number by series of 9's, Division by urdhva triyak sutra (vinculum method). | 10 |
| II | Square of any two-digit number- Base method, Duplex method, Square of number ending with 5-ekadhikena purvena sutra, Easy square roots- Dwandwa yoga(Duplex) sutra, square root of 2-baudhayana shulba sutra, Cubing-yavadnam sutra, Cube root, Factoring the quadratic equation by Anurupyena, Adyamadyenantyamanty Sutra, Roots of quadratic equation, Partial fraction. | 10 |
| III | Matrices and its properties, Determinant- Paravartya yojayet, Anurupye sunayamanyat, Inverse of matrices. | 10 |

**Essential/ Recommended Readings:**


1. Elements of Vedic Mathematics, Udayan S. Patankar, Sunil M. Patankar, TTU press (2018)
2. Vedic Mathematics, Swami Bharati Krishna Trithaji, Motilal Banarsidas, New Delhi. (1965)
3. Vedic Mathematics, Pragati Publication 2021.


| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: First** | **Semester: Second** |
| Course Code: | Course Type: MJCC-IV |

| Core: **Compulsory** | Course Title: Group Theory |
|---|---|
| Credits (in hours per week):4 | 3L-1T-0P |
| Internal Assessment: 30% | External Assessment: 70% |

**Course Outcomes:**

This course will enable the students to:

- ✓ Understand groups, subgroups, cosets, normal subgroups, quotient groups, and their properties in detail.
- ✓ Apply Lagrange's theorem to solve problems related to finite groups, to determine the order of subgroups and understand its implications.
- ✓ Analyze the structure and properties of subgroups generated by subsets. Classify subgroups of cyclic groups and understand their structure.
- ✓ Use the class equation to analyze group structure. Differentiate between external and internal direct products of groups. Apply the fundamental theorem on homomorphisms of groups.

| Unit | Topics | No. of Hours |
|---|---|---|
| I | Subgroups, Cosets, Lagrange's theorem and its applications, Euler's theorem, Fermat's little theorem, Product of two subgroups, Cyclic groups, Classification of Subgroups of cyclic groups. | 15 |
| II | Subgroups generated by a subset of a group, generating system of a group. Normal subgroups, Conjugate elements, Normalizer (Centralizer)of an element of a group, Class equation of a group, Centre of a group, Conjugate subgroups, Invariant subgroups. | 15 |
| III | Quotient group, Kernel of a Homomorphism and related theorems. Group automorphism, Inner automorphism, Automorphism groups, Automorphism groups of finite and infinite cyclic groups. | 15 |
| IV | Direct product of a finite number of groups: External direct product (EDP) &Internal direct product (IDP), Fundamental theorem on homomorphism of groups, Second and third laws of isomorphism of groups. | 15 |

**Essential/ Recommended Readings:**

1. I. N. Herstein, Topics in Algebra, John Wiley & Sons, 2006
2. Joseph A Gallian, Contemporary Abstract Algebra, Brooks/Cole Cengage Learning, 2016
3. David S. Dummit & Richard M. Foote: Abstract Algebra, Wiley, 3rd Edition, 2011
4. J.B. Fraleigh, A first course in Abstract Algebra, Addison-wiley, 2003

| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: First** | **Semester: Second** |
| Course Code: | Course Type: MJCC-V |
| Core: **Compulsory** | Course Title: Geometry & Vectors |
| Credits (in hours per week): 4 | 3L-1T-0P |
| Internal Assessment: 30% | External Assessment: 70% |

**Course Objectives:** The primary objective of this course is to introduce the understanding of the coordinate system. The other objectives of this course is to understand the tracing the curves.

**Course Outcomes:**

- ✓ Identification and tracing of the different conics.
- ✓ Identification of the equation of sphere, finding family of spheres passing through a circle, tangent planes and normal lines to a sphere.
- ✓ Learn to find equation of cone, enveloping cone, cylinder, and enveloping cylinder.
- ✓ Find equation of tangent plane to different conicoid and enveloping cone of a conicoid. Understand the concept of paraboloids and generating lines.

| Unit | Topics | No. of Hours |
|---|---|---|
| I | Multiple products; Scalar triple products, Vector triple products, Properties of scalar and vector triple products, Differentiation and integration of vectors, Gradient, Divergence and Curl, Green's, Gauss and Stoke's theorem. | 20 |
| II | System of Co-ordinates, Distance between two given points, Direction cosines, Relation between the direction cosines. Method for finding the direction cosines of a vector, Projections, Angle between two lines of a vector, The plane, General equation of a plane and related results, The straight line, General form of a straight line and related results. | 15 |
| III | Sphere: Plane section of a sphere. Sphere through a given circle. Intersection of two spheres, radical plane of two spheres. Cones: Right circular cone, enveloping cone and reciprocal cone. | 15 |
| IV | Cylinder: Right circular cylinder and enveloping cylinder. The Central conicoid, Important properties of the central conicoid in standard form. | 10 |

**Essential/ Recommended Readings:**


1. Analytical Solid Geometry by Shanti Narayan and P.K. Mittal, S. Chand & Company Ltd. 7th Edition. (2007)
2. A text Book of Analytical Geometry of Three Dimensions, by P.K. Jain and Khaleel Ahmed, Wiley Eastern Ltd., 1999.
3. Co-ordinate Geometry of two and three dimensions by P. Balasubrahmanyam, K.Y. Subrahmanyam, G.R. Venkataraman, Tata-McGraw-Hill, New Delhi. (2010)

4. Robert J. T Bell, An Elementary Treatise on Coordinate Geometry of three dimensions, Macmillan India Ltd., 1923
5. P. R. Vittal, Analytical Geometry 2d&3D, Pearson, 2013
6. S. L. Loney, The Elements of Coordinate Geometry, McMillan and Company, London. 2018
7. Suggested digital platform: NPTEL/SWAYAM/MOOCs

| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: First** | **Semester: Second** |
| Course Code: | Course Type: MJCC-VI |
| Core: **Compulsory** | Course Title: Ordinary differential equations |
| Credits (in hours per week):4 | 3L-1T-0P |
| Internal Assessment: 30% | External Assessment: 70% |

**Course Outcomes:**

- ✓ Find general solutions to homogeneous and non-homogeneous differential equations.
- ✓ Solve ordinary differential equations under appropriate assumptions.
- ✓ Analyze the system of ordinary differential equations.
- ✓ Evaluate properties of stability for linear and non-linear systems

| Unit | Topics | No. of Hours |
|---|---|---|
| I | Formation of differential equations, Geometrical meaning of a differential equation, Equation of first order and first degree, Equation in which the variables are separable, Homogeneous equations, Exact differential equations and equations reducible to the exact form, Linear equations. | 15 |
| II | First order higher degree equations solvable for x, y, p, Clairaut's equation and singular solutions, orthogonal trajectories, Linear differential equation of order greater than one with constant coefficients, Cauchy- Euler form. | 15 |
| III | Second and Higher Order Differential Equations General solution of homogeneous equation of second order, Principle of superposition for a homogeneous equation; Wronskian, its properties and applications. Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, Method of undetermined coefficients, Method of variation of parameters, Applications of second order differential equations to mechanical vibrations. | 15 |

| | | |
|---|---|---|
| IV | Bessel and Legendre functions and their properties, Orthogonal properties, recurrence Formula and generating Function. | 15 |

**Essential/ Recommended Readings:**


1. Ross, S.L. "*Differential equations*". Wiley Publication, 3rd edition, 2014.
2. Tyn Myint U, Ordinary differential equations, Elsevier North-Holland, 1978
3. Simmons G.F. "Ordinary Differential Equations with Applications". TMH, 2003.
4. Joshi, M.C. "*Ordinary Differential Equations (Modern Perspective)***".** Narosa Publishing House, 2006.
5. Wolfgang Walter, Ordinary different Equation, 1998
6. Suggested digital platform: NPTEL/SWAYAM/MOOCs
7.


| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: First** | **Semester: Two** |
| Course Code: | Course Type: Minor (MNEC) |
| Core: **Elective** | Course Title: **Matrix Theory** |
| Credits (in hours per week): 4 | 3L-1T-0P |
| Assessment | |

**Course outcomes:**

After completing this course a student will have:

- ✓ Knowledge of matrices, its transpose and conjugate transpose.
- ✓ Knowledge of symmetric, skew-symmetric, Hermitian and skew–Hermitian matrices.
- ✓ Concepts of rank, elementary transformation and inverse of a matrix. Knowledge of vector spaces and sub-spaces.
- ✓ Ability to solve system of linear equations. Knowledge of various types of quadratic forms.

| Unit | Topic | No. of Lectures |
|---|---|---|
| I | Algebra of matrices, transpose, conjugate and conjugate transpose of a matrix with their properties. Symmetric, Skew-symmetric, Hermitian and Skew–Hermitian matrices with their characteristics and related theorem, associative and distributive laws of matrices, trace of matrix with its properties. Concept of idempotent, Involuntary and Nilpotent matrices, adjoint of a square matrix, Inverse of a matrix and the related theorems. | 15 |
| II | Concept of rank, rows and column elementary transformations, Inverse theorem of rank through E-transformation. Rank of a product of two matrices, Normal form of a matrix, reduction of matrix to its normal form, elementary matrices and their inverses. Vector and vector–space, Linearly | 15 |

| | | |
|---|---|---|
| | dependent and independent set of vectors with related theorems, Sub-Space of an n-vector space, Basis of a sub space. | |
| III | System of linear homogeneous and non-homogeneous equations, Theorem related to linearly independent solutions of linear homogeneous equations. Necessary and sufficient conditions for the consistency of a system of non-homogeneous equations. Characteristic matrix, equation and roots of a square matrix, Caley Hamilton theorem and inverse of a matrix by using this theorem, Unitary and Orthogonal matrices, Inner product of vectors and length of a vector, Orthogonal vectors. | 15 |
| IV | Quadratic forms, Congruence of quadratic forms, Canonical form, reduction of quadratic forms into their canonical forms, Elementary congruent transformation, Definite, semi-definite and indefinite quadratic forms, Orthogonal reduction of a real symmetric matrix. | 15 |

**Suggested Readings:**

1.Narayan, S., A Text Book of Matrices, S Chand & Co. Ltd., New Delhi. (2010)
2.Bishwas S., A Text Book of Matrix Algebra, Khanna Publications, New Delhi.(2012)
3.Saran, N., "Introduction to matrices" (publisher and year) Pragati Books Private Limited (2013)

| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: First** | **Semester: Second** |
| Course Code: | Course Type: Minor (MNGEC) |
| Core: Minor Generic Elective | Course Title: Ordinary differential equations |
| Credits (in hours per week):4 | 3L-1T-0P |
| Internal Assessment: 30% | External Assessment: 70% |

**Course Outcomes:**

- ✓ Find general solutions to homogeneous and non-homogeneous differential equations.
- ✓ Solve ordinary differential equations under appropriate assumptions.
- ✓ Analyze the system of ordinary differential equations.
- ✓ Evaluate properties of stability for linear and non-linear systems

| **Unit** | **Topics** | **No. of Hours** |
|---|---|---|
| I | Formation of differential equations, Geometrical meaning of a differential equation, Equation of first order and first degree, Equation in which the variables are separable, Homogeneous equations, Exact differential equations and equations reducible to the exact form, Linear equations. | 15 |

| | | |
|---|---|---|
| II | First order higher degree equations solvable for x, y, p, Clairaut's equation and singular solutions, orthogonal trajectories, Linear differential equation of order greater than one with constant coefficients, Cauchy- Euler form. | 15 |
| III | Second and Higher Order Differential Equations General solution of homogeneous equation of second order, Principle of superposition for a homogeneous equation; Wronskian, its properties and applications. Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, Method of undetermined coefficients, Method of variation of parameters, Applications of second order differential equations to mechanical vibrations. | 15 |
| IV | Bessel and Legendre functions and their properties, Orthogonal properties, recurrence Formula and generating Function. | 15 |

**Essential/ Recommended Readings:**

1.Ross, S.L. "*Differential equations*". Wiley Publication, 3rd edition, 2014.
2.Tyn Myint U, Ordinary differential equations, Elsevier North-Holland, 1978
3.Simmons G.F. "Ordinary Differential Equations with Applications". TMH, 2003.
4.Joshi, M.C. "*Ordinary Differential Equations (Modern Perspective)*". Narosa Publishing House, 2006.
5.Wolfgang Walter, Ordinary different Equation, 1998
6.Suggested digital platform: NPTEL/SWAYAM/MOOCs

| | |
|---|---|
| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
| **Year: First** | **Semester: Second** |
| Course Code: | Course Type: SEC-II |
| Core: **Compulsory (Elective)** | Course Title: Mathematica |
| Credits (in hours per week): 2 | 1L-0T-1P |
| Internal Assessment: 30% | External Assessment: 70% |

**Course Objectives:**

- ✓ Equip students with foundational skills in Mathematica. Provide knowledge of mathematical and graphical tools in Mathematica to analyze and visualize mathematical functions.

**Course Outcomes:**

- ✓ Gain proficiency in essential Mathematica functions.
- ✓ Utilize the Mathematica notebook interface and basic programming constructs.
- ✓ Perform advanced mathematical operations.

- ✓ Create and customize 2D and 3D plots, histograms, scatter plots, and interactive visualizations.

| Unit | Topics | No. of Hours |
|---|---|---|
| I | **Getting Started with Mathematica:** Wolfram Cloud: Sign-in, usage, mobile app, Introduction to Mathematica, Notebook Interface**,** Mathematica as a Calculator, Using Built-in Functions, Variables and Functions, Lists, Basic Programming Constructs, Importing and Exporting Data, Manipulating Expressions, Mathematical Operations. | 15 |
| II | **Mathematics and Graphics:** Mathematical functions, Function Domain and Range, Limits, Differentiation, Maximum and Minimum, Integration. Matrices, Polynomials, Equation Solving, Graphic Data: Creating and customizing histograms, scatter plots, and bar charts, Basic Plotting: Creating 2D plots, customizing plot appearance, and adding labels and legends, Advanced Plotting Techniques: 3D plotting, parametric plots, and interactive visualizations. | 15 |

**Essential/ Recommended Readings:**


- Wellin, P. (2013). Programming with Mathematica: An Introduction (1st ed.). Cambridge University Press.
- Hastings, C., Mischo, K., Michael M. (2015). Hands-on start to Wolfram Mathematica (1st ed.). Champaign: Wolfram Media, Inc.
- Stephen Wolfram(2003). The Mathematica Book, 5th Edition, Wolfram Media, USA.


| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: Second** | **Semester: Third** |
| Course Code: | Course Type: MJCC-VII |
| Core: **Compulsory** | Course Title: Ring Theory |
| Credits (in hours per week):4 | 3L-1T-0P |
| Internal Assessment: 30% | External Assessment: 70% |

**Course Outcomes:**

This course will enable the students to:

- ✓ Understand rings and its types, subrings, subfields, ideals, quotient rings, and their properties in detail.
- ✓ Differentiate among integral domains, fields, and division rings (or skew fields). Understand and utilize quotient rings (residue class rings)
- ✓ Recognize and utilize maximal ideals, prime ideals, Principal ideals, Euclidean rings, the ring of Gaussian integers, and their properties.
- ✓ Develop ability of abstract reasoning and constructing rigorous mathematical proofs within the context of ring theory.

| Unit | Topics | No. of Hours |
|---|---|---|
| I | Rings, Elementary properties of Ring, Ring with or without zero divisors, Integral domains and field, Division ring or skew field, Subrings, Subfields, Characteristic of a ring. | 15 |
| II | Divisibility in an integral domain, Units and associates, Irreducible elements and GCD, Polynomial rings, Polynomial over an Integral domain, Division algorithm for polynomial over a field, Euclidean algorithm for polynomials over a field. | 15 |
| III | Rings of endomorphisms of an abelian group, Ring homomorphism, Ring Isomorphism, Kernel of a ring homomorphism and related theorems, Fundamental theorem on homomorphism of groups, | 15 |
| IV | Ideals, Principal ideal, Principal ideal ring, Prime ideal, Maximal Ideals, Prime ideals, Prime fields, Quotient rings or residue class rings. Euclidean rings or Euclidean domains, The ring of Gaussian integers, Properties of Euclidean rings. | 15 |

**Essential/ Recommended Readings:**

1. I. N. Herstein, Topics in Algebra, John Wiley & Sons, 2006.
2. Joseph A Gallian, Contemporary Abstract Algebra, Brooks/Cole Cengage Learning, 2016.
3. David S. Dummit & Richard M. Foote: Abstract Algebra, Wiley, 3rd Edition, 2011.
4. J.B. Fraleigh, A first course in Abstract Algebra, Addison-wiley, 2003.

| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: Second** | **Semester: Third** |
| Course Code: | Course Type: MJCC-VIII |
| Core: **Compulsory** | Course Title: Integral Calculus |
| Credits (in hours per week): 4 | 3L-1T-0P |

| Internal Assessment: 30% | External Assessment: 70% |
|---|---|

**Course Outcomes:**

- ✓ Evaluate indefinite and definite integrals and reduction.
- ✓ Learn to apply definite integrals. Understand the Beta and Gamma functions, their properties, and applications.
- ✓ Apply definite integral to find arc length, volumes of solids with different methods.
- ✓ Familiarize with the concept of multiple integrals, their evaluation and applications.

| Unit | Topics | No. of Hours |
|---|---|---|
| I | **Reduction Formulae**<br>Reduction formulae for Trigonometric functions, Reduction formulae for Algebraic functions and Reduction formulae for transcendental functions, Numerical Examples. | 15 |
| II | **Beta and Gamma Functions**<br>Beta function, Definition, Properties of Beta functions, another form of Beta function, Transformations of Beta function, Gamma Function, Properties of Gamma functions, Transformations of gamma function, Relation between Beta and Gamma, Duplication formula, Numerical Examples. | 15 |
| III | **Multiple Integrals**<br>Double Integrals, Properties of a double integra, Evaluation of Double integrals, Double integral in polar coordinates, Triple integral, Evaluation of Triple integral, Change of the order of Integration, Change of variables in double integral, Dirichlet's integral and Liouville's integral; Dirichlet's theorem for three variables and n variables, Liouville's Extension of Dirichlet's Theorem. | 15 |
| IV | **Area, Surface Area and Volumes**<br>Area of Curves given by cartesian equations and polar equations, rectification, length of curves in cartesian, parametric and polar forms, Surface area of curves, Revolution about the axis of x and axis of y and curve is in polar coordinates, and Volumes of solids of revolution rotation being x-axis and rotation being y-axis, and curve is given polar coordinates. | 15 |

**Essential/ Recommended Readings:**


1. Gorakh Prasad, (2015) Integral Calculus, Pothishala Publication.2015
2. R.G. Bartle & D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons.2011
3. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc., 2002.
4. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2007.
5. Shanti Narayan & Dr. P.K. Mittal,(2016) Integral Calculus, S. Chand., 2016
6. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons., 2011
7. Dennis G. Zill, Advanced Engineering Mathematics, Jones & Bartlett Learning**.**
8. Frank Ayres, Jr. & Elliott Menselson, Differential and Integral Calculus, Schaum's ouTlines, 1990
9. Suggested digital platform: NPTEL/SWAYAM/MOOCS.

| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: Second** | **Semester: Third** |
| Course Code: | Course Type: MJCC-IX |
| Core: **Compulsory** | Course Title: Discrete Mathematics |
| Credits (in hours per week):4 | 3L-1T-0P |
| Internal Assessment: 30% | External Assessment: 70% |

**Course Outcomes:**

After completing this course, a student will have the knowledge :

- ✓ of the basic concepts of discrete mathematics used in computer science and other disciplines that involve formal reasoning. The topics include logic, counting, relations, Hasse diagram and Boolean algebra.
- ✓ in mathematical reasoning, combinatorial analysis, discrete structures and applications of lattice theory and Boolean algebra with their properties and applications.
- ✓ of design of circuits, logic gates, Karnaugh maps and skills to proof by using truth tables.
- ✓ to apply the basics of the automation theory, transition function and table.

| Unit | Topics | No. of Hours |
|---|---|---|
| I | **Propositional Logic-** Proposition logic, Basic logic, Logical connectives, truth tables, Tautologies, contradiction, modus ponens and modus tollens, validity, predicate logic, universal and existential quantification, proof by implication, converse, inverse contrapositive, contradiction, direct proof by using truth table. | 15 |
| II | **Relation**- Definition, types of relation, domain and range of a relation, pictorial representation of relation, properties of relation, partial ordering relation, representation of POSETS using Hasse diagram, chains, maximal and minimal point, greatest lower bound, least upperr bound, Lattices and algebraic system, basic properties, sublattices. | 15 |
| III | **Boolean Algebra-** Basic definitions and examples, Sub algebra, Boolean functions, Disjunctive normal form, Complete disjunctive normal form, conjunctive normal form, logic circuits, logic networks, design of circuits from given properties, logic gates, and Karnaugh maps. | 15 |
| IV | **Combinatorics-** Inclusion- exclusion, recurrence relations (nth order recurrence relation with constant coefficients, Homogeneous recurrence relations, Inhomogeneous recurrence relations), generating function (G.F.)(closed form expression, properties of G.F., solution of recurrence relations using G.F. solution of combinatorial problem using G.F. | 15 |

**Essential/ Recommended Readings:**

**1.** C. L. Liu (1986): Discrete Mathematics, Tata McGraw Hill,

**2.** Trembley and Manohar (2008): Discrete Mathematics with computer application, Tata McGraw Hill.
**3.** Kenneth H. Rosen (2012): Discrete Mathematics and Its Applications, McGraw- Hill.

| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: First** | **Semester: Third** |
| Course Code: | Course Type: Minor (MNGEC) III |
| Core: **Elective** | Course Title: **Real Analysis** |
| Credits (in hours per week): 4 | 3L-1T-0P |
| Assessment | |

**Course Outcomes:**

After completing this course a student will have:

- ✓ Knowledge of functions, limits with their properties.
- ✓ Ability to analyze the nature of functions.
- ✓ Knowledge of continuity and differentiability with its types. Ability to deal with double and multiple integrals.
- ✓ Knowledge of Laplace transforms. Ability to solve various types of system of differential equations.

| Unit | Topic | No. of Lectures |
|---|---|---|
| I | Introduction of Function, definition, type of functions, composition of functions and invertible function, binary operations, odd and even functions, bounded and unbounded functions, monotonic functions. Limit of a function, one side limit-right hand and left-hand limits, Continuous functions, discontinuity of a function, kinds of continuity, uniform continuity, theorems on continuity. | 15 |
| II | Differentiability: definition, meaning of sign of derivative, Rolle's theorem, geometrical interpretation of Rolle's theorem. Lagrange's mean value theorem, Taylor's theorem for expansion of functions with various forms of remainder. Maxima and minima, indeterminate forms, Jacobians. | 15 |
| III | Beta and gamma functions. Double and multiple integrals, change of order of integration, Dirichlet's theorem and its Liouville's extension. | 15 |
| IV | Laplace transforms and its properties such as additive property, derivative property, limit property, convolution property etc. Inverse Laplace-transform and its properties, Laplace-Stieltjes transform, | 15 |

| | | |
|---|---|---|
| | Mean, Variance and moments by using Laplace transforms. Laplace transforms solution of simple differential equations. | |

Suggested Readings:

Shanti Narayan and M.D. Raisinghania: Elements of Real Analysis. (2023) S. Chand
Shanti Narayan : A course of mathematical analysis. S. Chand (2021)
Rudin, W. : Principles of mathematical analysis, McGraw Hills, (2023)
Richardson, C.H.: An Introduction to calculus of finite differences, New York, Van Nostrand, 1954

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| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: Second** | **Semester: Third** |
| Course Code: | Course Type: MJEC |
| Core: **Elective** | Course Title: Elementary Number Theory & Cryptography |
| Credits (in hours per week):4 | 3L-1T-0P |
| Internal Assessment: 30% | External Assessment: 70% |

**Course Outcomes:**

This course will enable the students to:

- ✓ have hands-on easy and interesting mathematical concepts and their use cases.
- ✓ develop problem solving skills using mathematical concepts.
- ✓ relate mathematics with day-to-day applications in digital world
- ✓ learn basic text hiding techniques. know the utility of mathematics and foster interest in it.

| Unit | Topics | No. of Hours |
|---|---|---|
| I | Natural numbers, primes, Composites, integers, factorization, Binary, decimal, and ternary representation of integers. Greatest common divisors (GCD), Least common multiple (LCM), Relation between GCD and LCM, Simple questions including word problems. | 15 |
| II | Divisibility, Division algorithm, Euclidean algorithm, modular arithmetic, congruence and its properties, Simple questions including word problems. | 15 |
| III | Introduction to cryptography, History of cryptography, Cryptographic goals, XoR function, Hash function, Elementary idea of symmetric key cryptography (SKC) and public key cryptography (PKC), Merits, demerits | 15 |

| | | |
|---|---|---|
| | of SKC and PKC, difference between SKC and PKC. | |
| IV | Elementary idea of classical ciphers: Substitution and transposition ciphers, Monoalphabetic and polyalphabetic ciphers, Stream ciphers and block ciphers. From Caesar cipher to public key cryptography, Elementary idea of RSA cryptosystem. | 15 |

**Essential/ Recommended Readings:**

[1] David M. Burton: Elementary Number Theory, McGraw Hill Education; 7 edition, 2017.
[2] William Stallings, "Cryptography and Network Security: Principles and Practices", Pearson; 6th Edition, 2013.

| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: Second** | **Semester: First** |
| Course Code: | Course Type: MJEC |
| Core: **Elective** | Course Title: Integral Transform |
| Credits (in hours per week):4 | 3L-1T-0P |
| Internal Assessment: 30% | External Assessment: 70% |

**Course Outcomes:**

- ✓ Understand the foundation of Laplace Transforms including Laplace transforms of derivatives and integrals.
- ✓ Idea of inverse Laplace transform and its properties. Identify and apply Laplace transforms to solve ODE and PDE.
- ✓ Familiarization with Fourier series, its convergence, properties and its applications.
- ✓ Understand the basic idea of Fourier Transforms including fourier transforms of derivatives and integrals.

| **Unit** | **Topics** | **No. of Hours** |
|---|---|---|
| I | Integral Transform, Laplace transforms, Linearity property of Laplace transform, Functions of Exponential order, Laplace transform using Shifting theorems, Laplace transform of derivatives and integrals, Initial Value theorems, Laplace transform of periodic functions, Heaviside unit step function and Dirac delta function. | 15 |
| II | Inverse Laplace transforms and their properties, Null functions, shifting theorems, change of scale property, Inverse Laplace transform of derivatives and integrals, Multiplication and division by powers of p, Heaviside expansion theorem, Convolution, Convolution theorem, The Complex Inversion formula. | 15 |

| | | |
|---|---|---|
| III | Fourier series, Fourier Integral formula, Fourier transform, Inversion Theorem for Complex Fourier transform, Fourier sine and cosine transform, Inversion formula for sine and cosine Fourier transform, Trigonometric Fourier Series and its convergence, Fourier series of even and odd functions, Fourier half-range series, Multiple Fourier Transform, Modulation Theorem, Parseval's identity, Complex form of Fourier series. | 15 |
| IV | Finite Fourier Transforms, Finite Fourier sine and cosine transform, Inversion formula for finite Fourier sine and cosine transform, Multiple finite Fourier transforms, Operational properties of finite Fourier transform, Fourier sine and cosine transform, Combined Properties of finite Fourier sine and cosine transform, Convolution., | 15 |

**Essential/ Recommended Readings:**


1. E. Kreyszig. Advance Engineering Mathematics, John Wiley & Sons. 2011.
2. R.K. Jain and S.R.K. lyenger, Advanced Engineering Mathematics, Narosa Publishing House, 2009.
3. F. B. Hildebrand, Methods of Applied Mathematics, Courier Dover Publication, 1992.
4. L. Debanth and D. Bhatta, Integral Transforms and their Applications. 2nd Ed. Taylor and Francis Group, 2007.
5. Suggested digital platform: NPTEL/SWAYAM/MOOCS.


| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: Second** | **Semester: Third** |
| Course Code: | Course Type: (Minor) MJEC |
| Course Type: Elective | Course Title: **Computer Fundamentals and Programming in C Language** |
| Credits (in hours per week): 4 | 3L-1T-0P |
| Assessment: | |

**Course Outcomes:**

After completing this course, a student will have:

- ✓ Knowledge of computer architecture.
- ✓ An ability to operate computer systems.
- ✓ An ability to analyse a real-world problem and develop an algorithm.
- ✓ An ability to write computer software programs in C language. An ability to write C programs to compute statistical measures.

| Unit | Topic | No. of Lectures |
|---|---|---|
| I | **Basic Computer Structure:** Overview Of Computer System, Memory, | **15** |

| | | |
|---|---|---|
| | C.P.U, I/O Units, Higher and Lower Levels Computer Languages. Basic Concepts of Computer Softwares, Compilers, Operating Systems and Statistical Software packages. Number systems (Binary, Octal, Hexadecimal Systems). | |
| II | **Programming Methods:** Problem analysis, Algorithms, Flow charts, Programming designs, Criteria for a good programming method. | **10** |
| III | **C Programming Language:** Basic features of C Language, Constants, Variables and data types, Operators and expressions: arithmetic, relational and logical, Input and output statements with their formats, Decision making statements, Branching and looping, Arrays, User and system defined functions, Structures and pointers. | **20** |
| IV | C Language Programs for statistical methods such as Measures of central tendency, Dispersion and Moments. | **15** |

**Suggested Readings:**


Balagurusamy E. (1998). Programming in ANSI C, Tata Mc-Graw Hill Publishing company, Ltd. New Delhi.

Kanetkar Yashwant P. (1999). Let us C , BPB Publications, New Delhi.

Kernighan B.W and Ritchie Dennis M. (1997). The C Programming Language, Prentice Hall of India Pvt Ltd. New Delhi.

Raja Raman V. (1999). Computer Programming In C, Prentice Hall of India Pvt. Ltd. New Delhi.

Byron S. (1999). Programming with C, (Schaum's Outline) Tata Mc Graw Hill Publishing Company Ltd. New Delhi

deep K. Sinha, Priti Sinha (2020). Computer Fundamentals. BPB Publications, India.


| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: Second** | **Semester: Third** |
| Course Code: | Course Type: Sec-III |
| Core: **Compulsory (Elective)** | Course Title: MATLAB for Beginners |
| Credits (in hours per week):2 | 1L-0T-1P |
| Internal Assessment: 30% | External Assessment: 70% |

**Course Objectives:**

- Equip students with foundational knowledge of MATLAB. Enhance Proficiency in Programming and Mathematical Visualization.

**Course Outcomes:**

- ✓ Gain proficiency in MATLAB Interface and Functions.
- ✓ Apply MATLAB for advanced mathematical operations.
- ✓ Achieve expertise in designing and customizing a variety of graphical data representations.

| Unit | Topics | No. of Hours |
|---|---|---|
| I | **Getting Started with MATLAB:**<br>Introduction to MATLAB: Windows, Input & Output, Built-in Functions, Computations, External Interface and Tool boxes, Platform dependence, File Types, General Commands, Printing.<br>Programming in MATLAB: Creating and working with arrays, Creating and printing simple plots, Scripts and functions, Script files, Executing of function, Working with arrays and matrices, Importing and Exporting Data, Files and Directories. | 15 |
| II | **Mathematics and Graphics:**<br>Mathematical operations, Function properties: domains and ranges, Limit calculations, Differentiation, Finding maxima and minima, Integration. Matrix operations, Polynomial computations, Solving equations. Data visualization: designing and customizing histograms, scatter plots, and bar charts. Fundamental plotting: generating 2D plots, modifying appearance, adding labels and legends. Advanced visualization: creating 3D plots, parametric plotting, interactive visualizations. | 15 |

**Essential/ Recommended Readings:**


- Gilat, A. (2014). MATLAB: An introduction with Applications (5th ed.). John Wiley & Sons.
- Pratap, R. (2009). Getting started with MATLAB: a quick introduction for scientists and engineers. Oxford University Press, Inc.
- Patel, R. N., & Mittal, A. (2014). Programming in MATLAB®: A Problem-solving Approach. Pearson India.


| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: Second** | **Semester: Fourth** |
| Course Code: | Course Type: MJCC-X |
| Core: **Compulsory** | Course Title: Analysis-II |
| Credits (in hours per week):4 | 3L-1T-0P |
| Internal Assessment: 30% | External Assessment: 70% |

Course Outcomes:

After completing this course a student will :

- ✓ acquire a thorough understanding of fundamental concepts in Riemann integration, such as partitions, Riemann sums, and the interpretation of integrals as areas under curves.
- ✓ thebe able to apply techniques for evaluating Riemann integrals, including the use of anti-derivatives and the Fundamental Theorems of Calculus, to solve integration problems.
- ✓ develop the ability to distinguish between two types of improper integrals and determine their convergence or divergence using appropriate techniques.
- ✓ have the knowledge of functions of bounded variation with their properties.

| Unit | Topics | No. of Hours |
|---|---|---|
| I | Riemann integration: Partitions of closed and bounded interval, refinement of partitions, Darboux integral, basic properties of upper and lower sums, definition of Riemann integration, necessary and sufficient condition for Riemann integrability, examples, Riemann sum, definition of Riemann integration as a limit of sum and equivalence of two definitions, Riemann integrability of monotone and continuous functions, properties of Riemann integration. | 15 |
| II | Fundamental theorems: Definitions of piecewise continuous and piecewise monotone functions and their Riemann integrability, intermediate value theorem for integrals, Fundamental theorems of calculus, Mean value theorem of integral calculus, integration by parts, change of variable in an integral, average value of a function. | 15 |
| III | Improper integrals: Definition of improper integrals, improper integrals over an unbounded interval, improper integrals of unbounded functions, convergence of Beta and Gamma functions, comparison tests, general test for convergence, absolute convergence. | 15 |
| IV | Functions of bounded variation: Definition and examples, total variation, additive property of total variation, total variation on [a, x] as a function of x, functions of bounded variation expressed as the difference of increasing functions, continuous functions of bounded variation, curves and paths, rectifiable paths and arc length, additive and continuity properties of arc length, equivalence of paths, change of parameter. | 15 |

**Essential/ Recommended Readings:**

1. S. C. Malik, S. Arora (2018): Mathematical Analysis, New Age Publications.
2. R. G. Bartle, D. R. Sherbert (2015): Introduction to Real Analysis (4th ed.). Wiley India Edition. New Delhi.
3. T. M. Apostol (1985): Mathematical Analysis, Narosa Publishing, New Delhi.

| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: Second** | **Semester: Fourth** |
| Course Code: | Course Type: MJCC-XI |
| Core: **Compulsory** | Course Title: Mechanics |
| Credits (in hours per week):4 | 3L-1T-0P |
| Internal Assessment: 30% | External Assessment: 70% |

**Course Objectives:**

- To develop a rigorous understanding of statics of particles and rigid bodies using vector and analytical methods.
- To introduce principles of equilibrium, including virtual work and friction, for solving mechanical systems.
- To analyze stability of equilibrium using energy and work-based criteria.
- To familiarize students with advanced statical concepts and prepare a smooth conceptual transition to dynamics, including non-inertial frames.
- To develop critical thinking and problem-solving abilities through the application of fundamental mechanics principles to standard physical and engineering situations.

- ✓ **Course Outcomes:** On successful completion of the course, students will be able to demonstrate the following learning outcomes:
- ✓ **CO1 (Understand):** Explain fundamental concepts of force, moment, couple, and equilibrium for particles and rigid bodies in two and three dimensions.
- ✓ **CO2 (Apply):** Apply conditions of equilibrium to solve problems involving coplanar and concurrent force systems, including practical configurations such as strings, pulleys, and constrained bodies.
- ✓ **CO3 (Analyze):** Analyze rigid body systems using moments, couples, and centre of gravity to determine equilibrium configurations.
- ✓ **CO4 (Apply / Analyze):** Use the principle of virtual work and laws of friction to solve equilibrium problems.
- ✓ **CO5 (Evaluate):** Assess the stability of equilibrium of mechanical systems using potential energy methods, work function test, and Z-test.
- ✓ **CO6 (Understand / Apply):** Interpret advanced statical theories such as Poinsot's theory, null systems, and screw theory at a conceptual level.
- ✓ **CO7 (Understand):** Distinguish between inertial and non-inertial frames of reference and explain the origin and role of apparent forces such as centrifugal and Coriolis forces.
- ✓ **CO8 (Integrate):** Integrate concepts from statics to build a conceptual foundation for dynamics in rotating frames, enabling progression to advanced mechanics courses.

| Unit | Topics | No. of Hours |
|---|---|---|
| I | **STATICS OF A PARTICLE – FORCE SYSTEMS**<br>Introduction to mechanics; Force: definition, representation, and line of action; Composition and resolution of forces; Parallelogram law of forces; Resultant of coplanar forces; Necessary and sufficient conditions of equilibrium of a | 15 |

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|---|---|---|
| | particle under a system of forces; Forces in three dimensions; Equilibrium of a particle under concurrent forces in three dimensions; Simple applications including hanging bodies, strings, and pulleys. | |
| II | **STATICS OF RIGID BODIES – FORCE SYSTEMS**<br>Rigid body: definition and assumptions; Moment of a force about a point and about an axis; Varignon's theorem; Couple: properties and physical meaning; Resultant force and resultant couple; Invariance of a force system; Equilibrium of a rigid body; Constraints and constrained rigid bodies including equilibrium with one point fixed and with two fixed points; Centre of gravity of discrete bodies; Centre of gravity of continuous bodies; Centre of gravity of composite bodies. | 15 |
| III | **VIRTUAL WORK, FRICTION AND STABILITY OF EQUILIBRIUM**<br>Virtual displacement; Principle of virtual work; Applications to equilibrium of a particle on a smooth inclined plane; Equilibrium of a system of coplanar forces; Tension in a light inextensible string; Work done by thrust in a rigid rod; Equilibrium of a rigid body with one point fixed; Equilibrium of two bodies in contact with smooth surfaces; Friction: limiting friction, angle of friction, and cone of friction; Applications to ladder problems and a block on a rough plane; Stability of equilibrium: stable, unstable, and neutral equilibrium; Potential energy test for stability; Work function test for stability; Z-test for stability; Stability of a body resting on a fixed rough surface; Stability of a system in which the portions of two bodies in contact are spherical. | 15 |
| IV | **ADVANCED STATICS AND TRANSITION TO DYNAMICS**<br>Strings and chains: uniform string under gravity and catenary; General theory of force systems (conceptual): Poinsot's theory of force systems: central axis and physical interpretation; Null systems: null lines, null planes, and physical significance; Screw theory: screw, pitch, and wrenches with physical and engineering interpretation; Frame of reference and rotating systems: Inertial and non-inertial frames; Rotating frame and angular velocity of the frame; Transformation of velocity and acceleration; Apparent forces: centrifugal force and Coriolis force; Modified Newton's second law in a rotating frame; Simple applications including motion on a rotating platform, motion relative to the Earth. | 15 |

**Essential/ Recommended Readings:**


1. Synge, J. L., & Griffith, B. A. (2017): *Principles of Mechanics* (3rd ed.). McGraw-Hill Education, Indian Reprint.
2. Ray, M., & Sharma, G. C. (2018). *A textbook on dynamics*. S. Chand Publishing
3. Beer, F. P., Johnston, E. R. Jr., Mazurek, D. F., Cornwell, P. J. (2017): *Vector Mechanics for Engineers: Statics and Dynamics* (11th ed.), McGraw-Hill Education.
4. Hibbeler, R. C. (2016): *Engineering Mechanics: Statics & Dynamics* (14th ed.), Pearson Prentice Hall (Pearson Education), New Jersey.
5. Shames, Irving H., & Rao, G. Krishna Mohan (2009): *Engineering Mechanics: Statics and Dynamics* (4th ed.), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi.
6. Ramsey, A. S. (1985): *Statics* (2nd ed.), Cambridge University Press.
7. Meriam, J. L., Kraige, L. G. and Bolton, J. N. (2020): *Engineering Mechanics: Statics* (9th ed.), Wiley.
8. Kleppner, D. and Kolenkow, R. (2014): *An Introduction to Mechanics*, Cambridge University Press.

| with Research) | |
|---|---|
| **Year: Second** | **Semester: Fourth** |
| Course Code: | Course Type: MJCC-XII |
| Core: **Compulsory** | Course Title: Numerical Analysis |
| Credits (in hours per week):4 | 3L-1T-0P |
| Internal Assessment: 30% | External Assessment: 70% |

**Course Outcomes:**

- ✓ Employ the concept of errors and apply various numerical methods to find the roots of non-linear equations and solution of system of equations.
- ✓ Solve differentiation and integration for complex functions and apply interpolation formulas to find approximate polynomials and missing values.
- ✓ Solve ordinary differential equations using different numerical methods.
- ✓ Solve system of linear and nonlinear equations by numerical methods.

| Unit | Topics | No. of Hours |
|---|---|---|
| I | **Interpolation:** Error, Finite Difference Operator, Newton's Forward and Backward Interpolation, Lagrange's Interpolation, Newton's Divided Difference Interpolation, Inverse Interpolation. Derivatives from Difference Tables, Higher Order Derivatives, Newton – Cotes quadrature formula, Trapezoidal Rule, Simpson's 1/3 and 3/8 Rule, Boole's Rule, Weddle's Rule, Romberg's Method. | 15 |
| II | **Solution of Transcendental Equations:** Bisection Method, False Position Method, Method of Iteration, Newton-Raphson Method, Secant Method, Rate and Order of Convergence of Iterative Methods, Existence of the Solution of Iterative Methods. | 15 |
| III | **Solution of System of Linear and Non-linear Equations:** Pivoting, Gauss Elimination Method, Gauss-Jacobi Method, Gauss – Seidel Method, Computation of Eigen Values of a Matrix by Power Method, Inverse Power Method, Scaled Power Method, Newton's Method for Non-linear Equations. | 15 |
| IV | **Numerical solution to Ordinary Differential Equations:** Picard's Method, Tayler's Method, Euler Method and Modified Euler Method, Runge-Kutta Method, Milne's Method. | 15 |

**Essential/ Recommended Readings:**


1. Jain, M. K. (1997): Numerical Solution of Differential Equations, John Wiley.
2. Gerald, C. F. and Wheatly P. O. (2002): Applied Numerical Analysis, 6th Ed., Addison-Wesley Publishing .
3. Balagurusamy, E. (1999): Numerical Methods**,** Tata McGraw Hill Publication.

4. Bradie,B. (2006): A Friendly Introduction to Numerical Analysis. Pearson Education, India. Dorling Kindersley (India) Pvt. Ltd. Third impression 2011.
5. Sastry, S.S. (2012): Introductory Methods of Numerical Analysis, PHI Learning Pvt. Ltd.

| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: Second** | **Semester: Fourth** |
| Course Code: | Course Type: MJEC |
| Core: **Elective** | Course Title: Linear Programming and Applications |
| Credits (in hours per week): 4 | 3L-1T-0P |
| Internal Assessment: 30% | External Assessment: 70% |

**Course Outcomes:**

- ✓ Learn about the basic feasible solutions of linear programming problems.
- ✓ Understand the theory of the Simplex method to solve linear programming problems. Learn about the relationship between the primal and dual problems.
- ✓ Solve transportation and assignment problems.
- ✓ Understand two-person zero sum game, game with mixed strategies and formulation of game to primal and dual linear programming problems to solve using duality.

| Unit | Topics | No. of Hours |
|---|---|---|
| I | **Introduction to Linear Programming**<br>Linear programming problem: Standard, Canonical and matrix forms, Geometric solution; Convex and polyhedral sets, Hyperplanes, Extreme points; Basic solutions, Basic feasible solutions, Reduction of feasible solution to a basic feasible solution, Correspondence between basic feasible solutions and extreme points. | 15 |
| II | **Optimality of Linear Programming Problem**<br>Simplex method: Optimal solution, Termination criteria for optimal solution of the linear programming problem, Unique and alternate optimal solutions, Unboundedness; Simplex, Algorithm and its tableau format; Artificial Variables, Two Phase method, Big-M method. | 15 |
| III | **Duality Theory of Linear Programming and Game Theory**<br>Motivation and formulation of dual problem, Primal-Dual relationships, Fundamental theorem of duality, Complimentary slackness, Game Theory, two-person zero sum game, Game with mixed strategies, Formulation of | 15 |

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|---|---|---|
| | game to primal and dual linear programming problems, Solution of game using duality. | |
| IV | **Applications: Transportation and Assignment Problem**<br>Necessity of transportation Pproblem, Definition and formulation, Methods of finding initial basic feasible solutions, Northwest-corner rule. Least- cost metho,; Vogel's approximation method,Algorithm for solving transportation problem**,** Necessity of assignment problem, Introduction to Assignment Problem, Mathematical formulation of Assignment problems. Hungarian method of solving Assignment Problems. | 15 |

**Essential/ Recommended Readings:**

1. Bazaraa, Mokhtar S., Jarvis, John J., and Sherali, Hanif D. (2010). Linear Programming and Network Flows (4th ed.). John Wiley and Sons.
2. Hadley, G. (1997). Linear Programming, Narosa Publishing House, New Delhi
3. Taha, Hamdy A. (2010). Operations Research: An Introduction (9th ed.).,Pearson.
4. Hillier, Frederick S. and Lieberman, Gerald J. (2021). Introduction to Operations Research (11th ed.).,McGraw-Hill Education (India) Pvt. Ltd.
5. Thie, Paul R., & Keough, G. E. (2014). An Introduction to Linear Programming and Game Theory, (3rd ed.).,Wiley India Pvt. Ltd.
5. Suggested digital plateform: NPTEL/SWAYAM/MOOCs

| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: Second** | **Semester: Fourth** |
| Course Code: | Course Type: MJEC |
| Core: **Elective** | Course Title: Introduction to Fuzzy Sets |
| Credits (in hours per week): 4 | 3L-1T-0P |
| Internal Assessment: 30% | External Assessment: 70% |

**Course Objectives:**

The aim is to equip students with some state-of-the-art fuzzy-logic technology to better prepare them for the rapidly evolving high-tech information-based modern industry and market.

**Course Outcomes:**

- ✓ This course helps to solve those problems which are described in linguistic terms.
- ✓ This course provides an excellent tool to handle the vagueness in modern science and technology problems such as computer science, economics and medical science.
- ✓ It can be used to make modern systems based on Artificial Intelligence (AI) and soft computing.
- ✓ On the basis of this theory many real-life problems can be solved such as robotics, management etc.

| Unit | Topics | No. of Hours |
|---|---|---|
| I | Introduction: Basics concepts on crisp sets, Fuzzy sets, Representation methods of Fuzzy set, Examples of Fuzzy sets, $\alpha - Cut$ of a fuzzy set, Strong $\alpha - Cut$ of a fuzzy set, Level set, Properties of $\alpha - Cut$ and strong $\alpha - Cut$ of a fuzzy set, The support of a fuzzy sets, Core of a fuzzy set, Height of a fuzzy set, Normal fuzzy set, subnormal fuzzy set, Normalization of fuzzy sets. | 15 |
| II | Standard operations of fuzzy sets, The Magnitude of Fuzzy set, Subset of a fuzzy set, Properties of fuzzy sets, Fuzzy point, Subsethood degree of a fuzzy set in another fuzzy set, Hamming distance, Non-specificity of Crisp sets, Non-specificity of fuzzy sets, Fuzziness of fuzzy sets, construction of fuzzy sets. | 15 |
| III | Interval Arithmetic: Interval numbers, Classification of intervals, Arithmetic operations on intervals, Fuzzy numbers, Triangular fuzzy Number, Trapezoidal Fuzzy Number, Arithmetic operations of fuzzy number, Interval Fuzzy Arithmetic, Fuzzy Equations. | 15 |
| IV | Fuzzy Relations: Introduction to Fuzzy relation, Binary Fuzzy relation, domain, range and height of a binary fuzzy relation, Inverse of a binary fuzzy relation, Max-Min composition of a binary fuzzy relation, Relational Join, Fuzzy equivalence Relations, Fuzzy partial order relations. | 15 |

**Essential/ Recommended Readings:**

**1.** Dubosis Didler and Prade, Henri, Fuzzy Sets and systems Theory and Applications, Academic Press, NewYork, 1980.
**2.** Klir Georage. J and Yuan Bo, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall of India, New Delhi. 2009.
3. Lee, Kwang H., First Course on Fuzzy Theory and Applications, Springer International Edition, 2009.
4. Ross, Timothy J. , Fuzzy Logic with Engineering Applications, McGraw Hills inc., New Delhi, 2004.
5. Roger, Jyh-Shing; Sun, Chuen-Tsai; Mizutani, Eiji, Neuro-fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, *MATLAB curriculum series,* illustrated, reprint, Prentice Hall, 1997.
6. Zimmermann, H.J. Fuzzy Set Theory & its Applications, Allied Publishers Ltd. New Delhi, 2006.

| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: Second** | **Semester: Fourth** |
| Course Code: | Course Type: MNGEC |

| Core: **Elective** | Course Title: **Numerical Methods** |
|---|---|
| Credits (in hours per week): 4 | 3L-1T-0P |
| Internal Assessment: 30% | External Assessment: 70% |

**Course outcomes:**

After completing this course a student will have:

- ✓ Knowledge of types of errors.
- ✓ Ability to solve non-linear equations using iterative methods.
- ✓ Ability to interpolate value of dependent variable using past data.
- ✓ Ability to differentiate complex functions numerically. Ability to numerically solve complex integrals.

| Unit | Topic | No. of Lectures |
|---|---|---|
| I | **Errors in Computation-** Floating point representation of numbers, Significant Digits, Rounding and chopping, Absolute and relative errors, computation of errors using differentials, Truncation error. **Solution of non-linear equations:** Bisection method, Newton Raphson's method, Successive iteration method. | **20** |
| II | **Interpolation-**Some operators and their properties, Finite difference table, Error in approximating a function by polynomial, Newton forward and backward Difference formulae, Gauss forward and backward formulae, Stirling's and Bessel's formulae, Lagrange's method, Divided differences and Newton's divided difference formula. | **20** |
| III | **Numerical Differentiation** - Differentiation methods based on Newton's forward and backward formulae, Differentiation by central difference formula. | **10** |
| IV | **Numerical Integration:** Trapezoidal, Weddle, Simpson's Newton Cotes Formulas, Gaussian Quadrature Formulas. | **10** |

**Suggested Readings:**

R. K. Gupta, Numerical methods: Fundamental and Applications, 1st Edition, Cambridge University Press. (2019)

M. K. Jain, S. R. K. Iyengar & R. K. Jain (2012). Numerical Methods for Scientific and Engineering Computation (6th edition). New Age International Publishers.

Brian Bradie (2006), A Friendly Introduction to Numerical Analysis. Pearson.

C. F. Gerald & P. O. Wheatley (2008). Applied Numerical Analysis (7th edition), Pearson Education, India.

F. B. Hildebrand (2013). Introduction to Numerical Analysis: (2nd edition). Dover Publications.

Robert J. Schilling & Sandra L. Harris (1999). Applied Numerical Methods for Engineers Using MATLAB and C. Thomson-Brooks/Cole.

| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: Second** | **Semester: Fourth** |
| Course Code: | Course Type: SEC-IV |
| Core: **Compulsory (Elective)** | Course Title: Computer Algebra System |
| Credits (in hours per week): 2 | 1L-0T-1P |
| Assessment: | |

**Course Objectives:**

Equip students with the ability to proficiently use Computer Algebra Systems (CAS) for a variety of mathematical operations. Provide comprehensive knowledge and practical skills in advanced matrix operations and systems solving.

**Course Outcomes:**

- ✓ Students will be able to effectively use Computer Algebra Systems for calculations.
- ✓ Students will gain insights into matrix theory and linear algebra.
- ✓ Students will be adept at solving algebraic and trigonometric equations.
- ✓ Students will have the practical skills of matrix and system solving operations.

| Unit | Topics | No. of Hours |
|---|---|---|
| I | **Introduction to CAS and Applications in Algebra:** Computer Algebra Systems (CAS), Use of CAS as a calculator, Simple programming in CAS, Computing and plotting functions in 2D, Customizing and animating plots, Producing tables of values, Working with piecewise-defined functions, Combining graphics, Factoring and expanding polynomials, Finding roots of polynomials, Working with rational and trigonometric functions, Solving general equations. | 15 |
| II | **Advanced Applications in Matrices and System Solving:** Performing Gaussian elimination, Matrix operations: transpose, determinant, inverse, Minors and cofactors, Solving systems of linear equations, Rank and nullity of a matrix, Eigenvalues and eigenvectors, Diagonalization. | 15 |

**Essential/ Recommended Readings:**

1.Bindner, Donald & Erickson, Martin. (2011). A Student's Guide to the Study, Practice, and Tools of Modern Mathematics. CRC Press, Taylor & Francis Group, LLC.

2.Torrence, Bruce F., & Torrence, Eve A. (2009). The Student's Introduction to Mathematica®: A Handbook for Precalculus, Calculus, and Linear Algebra (2nd ed.). Cambridge University Press.

| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
|---|---|
| **Year: First** | **Semester: Second Semester** |
| Course Code: | Course Type: VAC -II (From MOOCS) |
| Core: **Compulsory (Elective)** | Course Title: Any one of the following<br>**1. Logic & Sets**<br>**2. Effective Decision Making**<br>**3. Human Growth & Development** |
| Credits (in hours per week): 2 | Assessment: Through MOOCS |

1. Logic and Sets

Introduction to Logic and Logical Propositions, Truth Table, Negation, Conjunction and Disjunction, Implications, Biconditional Propositions and Converse and Contra Positive Propositions, Inverse Propositions and Precedence of Logical Operators , Logical Equivalences, Predicates and Quantifiers: Quantifiers, Binding Variables and Negations, Introduction to Sets and Subsets, Set Operations and The Laws of Set Theory, Venn Diagrams, Examples of Finite and Infinite Sets, Finite Sets and Counting Principle, Empty Set, Properties of Empty Set, Standard Set Operations, Classes of Sets, Power Set of a Set, Difference and Symmetric Difference of Two Sets, Set Identities, Generalized Union and Intersections, Relation on Sets, Product Set Composition of Relations , Types of Relations, Partitions of a Set, Equivalence Relations 1, Equivalence Relations 2, Partial Ordering Relations and n –ary Relations.

2. **Effective Decision Making** [2 Credit]

BASICS OF DECISION MAKING & PROBLEM SOLVING, Decision making- an Introduction, To understand the concept of decision making. To understand nature of decision making. To understand characteristics of decision making. To understand various types of decisions. To understand the various factors affecting decision making. To understand the various theories of decision making. Background Decision making.

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3.Human Growth and Development [2 Credit]

Course layout

Concepts and Theories of Human Development, Meaning, Definition & Principles of Growth Development, Development periods in human life span (Prenatal development, Infancy, Childhood, Adolescence, Adulthood), Heredity and environment on development, Domains of Human Growth and Development, Theories of Erikson, Piaget & Kohlberg, Social Learning Theory (Albert Bandura), Ecological Theory (Bronfrenbrenner), Holistic Theory of Development (Steiner), Meaning & Definition of Personality, Theories of Personality, Pre-natal Development – Conception, Pre-natal Development & Birth, Sensation, Sensation: Definition and Sensory Process, Attention: Definition and Affecting Factors, Perception: Definition and Types, Memory, Thinking, and Problem Solving, Physical and Emotional Growth and Development, Emerging capabilities across domains related to cognition - metacognition, creativity, ethics, Issues related to puberty, Gender Stereotyping Morality & Development, Influence of Development on the growing child, Psychological well-being, Formation of Identity and Self-Concept, Concept of Diversity and Type of Diversity, Diversity in Learning & Delivering the Diverse Learning Needs, Independent Living Skills – Meaning, Importance, Component, Transition to Adulthood – Sexuality, Marriage and Employment.

| | |
|---|---|
| Program: **B.Sc. (Honours/ Honours with Research)** | Subject: Mathematics |
| **Year: Second** | **Semester: Fourth Semester** |
| Course Code: | Course Type: VAC -IV (From MOOCS) |
| Core: **Compulsory (Elective)** | Course Title: Any one of the following<br>**4. Research and Publication Ethics**<br>**5. Research Ethics & Plagiarism**<br>**6. Entrepreneurship management** |
| Credits (in hours per week): 2 | Assessment: Through MOOCS |

1**. Research and Publication Ethics (RPE)**

Course layout

Philosophy and Ethics: Introduction to Philosophy, Origin of Philosophy, Characteristics of Philosophy, Common sense and Philosophy

Scientific Conduct: Integrity and Ethics, Ethics with Respect to Science & Research, Intellectual Honesty & Research Integrity, Scientific Misconducts & Redundant Publications, Selective Reporting and Misrepresentation of data, Relationship between Philosophy & Science

Publication Ethics: Best Practices/Standards Setting, Initiatives & Guidelines: COPE, WAMEM etc., Conflict of Interest; Publication Misconduct, Violation of Publication Ethics, Authorship and Contributor ship; Identification of Publication Misconduct, Complacent & Appeals, Predatory Publishers & Journals

Open Access Publishing: Concept of OER, Concept of open license, Open access publishing, oPen access content management.

Publication Misconduct: Ethical issues in various Disciplines, Fabrication, Falsification and Plagiarism (FFP), Authorship: Definition and types, Conflict of Interest, Complaints and Appeals, Software Tools.

Database and Research Metrics: Indexing Databases, Citation Databases : Web of Science, Scopus, Google Scholar, Metrics : h-index, g-ind, i10 index, Almetrics, Understanding Citation Metrics for Quality Research: Impact & Visualization Analysis, Exploring the Citation Network, Rules & Tools.

UGC Regulations 2018 on Academic Integrity: UGC Regulations-Meaning & concept, Legal Provisions

2**. Research Ethics and Plagiarism:**

Research Ethics and Scientific Conduct, Understanding Plagiarism, Types of Plagiarism, Plagiarism Detection Software, Publication Misconduct and Publication Ethics, Ways to avoid Plagiarism, Regulations on Plagiarism in India.

3. **Entrepreneurship Management**

Course layout Entrepreneurship Building, Analysing Marketing Opportunities- Part-A (Macro

Environmental Factors), Analysing Marketing Opportunities- Part-B (Micro Environmental Factors-1), Analysing Marketing Opportunities- Part-C (Micro Environmental Factors-2), Analysing Marketing Opportunities- Part-D (Vision), Ansoff's Grid, Market Survey Techniques, Project Formulation –I, Project Formulation –II, Project Appraisal –I, Project Appraisal – II, Project Appraisal-III, Financial Management –Part- A, Financial Management –Part- B, Human Resource Management – Part-A, Human Resource Management – Part-B, Leadership – Part-A, Leadership – Part-B, Leadership – Part-C, Statutory Provisions –I, Statutory Provisions –II.

In practical/ Practice papers there will be only external assessment