# University of Rajasthan
# Jaipur

# SYLLABUS

**I-VI Semester**
**Examination-2024-25 AND ONWARDS**
**UNDER NEP-2020**

# SYLLABUS

## SCHEME OF EXAMINATION AND COURSE OF STUDY

**UNDER NEP 2020**
**for**

**(SEMESTER SCHEME: I-VI Semester)**

## UG0809- Three/Four Years Bachelor of Science (Mathematics)

**Medium of Instruction: Hindi and English**

**(SEMESTER SCHEME)**

**EXAMINATION 2024-2025 AND ONWARDS**

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| | |
|---|---|
| **Name of University** | **University of Rajasthan, Jaipur** |
| **Name of Faculty** | **Science** |
| **Name of Discipline** | **Mathematics** |
| **Type of Discipline** | **Major** |
| **List of Programme were offered as Minor Discipline** | |
| **Offered to Non-Collegiate Students** | **No** |

## SEMESTER-WISE PAPER TITLES WITH DETAILS

| **UG0809- Three/Four Years Bachelor of Science (Mathematics)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | **Mathematics** | **Credits** | | | |
| **#** | **Level** | **Sem** | **Type** | **Title** | **L** | **T** | **P** | **Total** |

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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **1.** | **5** | **I** | **MJR** | **UG0809-MAT-51T-151**<br>**Discrete Mathematics & Optimization Techniques-I** | **6** | **0** | **0** | **6** |
| **2.** | **5** | **I** | **MJR** | **UG0809-MAT-51T-152**<br>**Number Theory** | **6** | **0** | **0** | **6** |
| **3.** | **5** | **II** | **MJR** | **UG0809-MAT-52T-153**<br>**Calculus** | **6** | **0** | **0** | **6** |
| **4.** | **5** | **II** | **MJR** | **UG0809-MAT-52T-154**<br>**Operations Research** | **6** | **0** | **0** | **6** |
| **5.** | **6** | **III** | **MJR** | **UG0809-MAT-63T-251**<br>**Real Analysis-I & Differential Equations-I** | **4** | **0** | **0** | **4** |
| **6.** | **6** | **III** | **MJR** | **UG0809-MAT-63P-252**<br>**Introduction to Scilab: A Mathematical Tool** | **0** | **0** | **2** | **2** |
| **7.** | **6** | **III** | **MJR** | **UG0809-MAT-63T-253**<br>**Mathematical Statistics** | **6** | **0** | **0** | **6** |
| **8.** | **6** | **IV** | **MJR** | **UG0809-MAT-64T-254**<br>**Real Analysis-II & Numerical Analysis** | **4** | **0** | **0** | **4** |
| **9.** | **6** | **IV** | **MJR** | **UG0809-MAT-64P-255**<br>**Introduction to C Programming: As Mathematical Tool** | **0** | **0** | **2** | **2** |
| **10.** | **6** | **IV** | **MJR** | **UG0809-MAT-64T-256**<br>**Advanced Analysis** | **6** | **0** | **0** | **6** |
| **11.** | **7** | **V** | **MJR** | **UG0809-MAT-75T-351**<br>**Abstract Algebra & Three Dimensional Geometry** | **6** | **0** | **0** | **6** |
| **12.** | **7** | **V** | **MJR** | **UG0809-MAT-75T-352**<br>**Optimization Techniques-II** | **6** | **0** | **0** | **6** |
| **13.** | **7** | **VI** | **MJR** | **UG0809-MAT-76T-353**<br>**Complex Analysis & Mechanics** | **6** | **0** | **0** | **6** |
| **14.** | **7** | **VI** | **MJR** | **UG0809-MAT-76T-354**<br>**Linear Algebra & Differential Equations-II** | **6** | **0** | **0** | **6** |

## Examination Scheme

1. 1 credit = 25 marks for examination/evaluation

2. For Regular Students, there will be Continuous assessment, in which sessional work and the terminal examination will contribute to the final grade. Each course in Semester Grade Point Average (SGPA) has two components- Continuous assessment (20% weightage) and (End of end-semester examination) EoSE (80% weightage).

3. For Regular Students,75% Attendance is mandatory for appearing in the EoSE.

4. To appear in the EoSE examination of a course/subject, a regular student must appear in the mid-semester examination and obtain at least a C grade in the course/subject.

5. Credit points in a Course/Subject will be assigned only if, the regular student obtains at least a C grade in the CA and EoSE examination of a Course/Subject.

**Examination Scheme for Continuous Assessment (CA)**

## DISTRIBUTION OF CONTINUOUS ASSESSMENT (CA) MARKS

| S. No. | CATEGORY | Weightage (out of total internal marks) | | THEORY | | | | | PRACTICAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | CORE (Only Theory) | CORE (Theory + Practical) | AEC | SEC | VAC | CORE (Theory +Practical) | SEC | VAC |
| | Max Internal Marks | | | 30 | 20 | 20 | 10 | 10 | 10 | 10 | 10 |
| 1 | Mid-term Exam | *50%* | | 15 | 10 | 10 | 5 | 5 | 5 | 5 | 5 |
| 2 | Assignment | *25%* | | 7.5 | 5 | 5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| 3 | Attendance | *25%* | | 7.5 | 5 | 5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| | | *Regular Class Attendance* | = 75% | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 |
| | | | 75-80% | 4 | 3 | 3 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| | | | 80-85% | 5 | 4 | 4 | 2 | 2 | 2 | 2 | 2 |
| | | | > 85% | 7.5 | 5 | 5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |

**Note:**

1. Continuous assessment will be the sole responsibility of the teacher concerned.
2. For continuous assessment no remuneration will be paid for paper setting, Evaluation, Invigilation etc.
3. For continuous assessment Paper setting and Evaluation responsibility will be of teacher concern.
4. For continuous assessment no Answer sheets/question papers etc. will be provided by the University.
5. Colleges are advised to keep records of continuous assessment, attendance etc.

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## Examination Scheme for EoSE-

CA – Continuous Assessment
EoSE – End of Semester Examination

## Regular Students –

### [Courses which have Practical Examination]

The question paper will consist of **two** parts **A** & **B**.

### PART-A: 20 Marks

Part A will be compulsory having question no. 1 of 10 very short answer-type questions of two marks each.

### PART-B: 60 Marks

Part B of the question paper shall be comprising question numbers 2-5. There will be one question from each unit with internal choice. Each question will carry 15 marks.

### [Courses which do not have Practical Examination]

The question paper consists of **three** parts A, B & C.

### PART-A: 20 Marks

Part A will be compulsory having question no.1 comprising 10 very short answer-type questions of two marks each.

### PART-B: 20 Marks

Part B of the paper shall consist of 4 questions viz. Question no. 2-5 having one question from each unit and the student shall attempt any 2 questions that carry 10 marks each.

### PART-C: 80 Marks

Part C of the question paper shall be comprising question numbers 6-9. There will be one question from each unit with internal choice. Each question will carry 20 marks.

### [Examination Scheme For Practical Examination]

The question paper consists of three practicals by taking one practical from each group A, B and C.

**(i) one practical from the group A : 10 Marks**

**(i) one practical from the group B: 10 Marks**

**(i) one practical from the group C : 10 Marks**

**(i) Viva-Voce : 05 Marks**

**(i) Practical Record : 05 Marks**

**Total : 40 Marks**

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# Syllabus

## [UG0809-Three/Four Year Bachelor of Science(Mathematics)] - [UG0809-MAT-51T-151] - [Discrete Mathematics & Optimization Techniques-I]

## I-Semester - [Mathematics]

| Type | Paper code and Nomenclature | Duration of Examination | Maximum Marks (CA + EoSE) | Minimum Passing Marks (CA + EoSE) |
|---|---|---|---|---|
| **Theory** | **UG0809-MAT-51T-151 Discrete Mathematics & Optimization Techniques-I** | **1 Hrs-CA 3 Hrs-EoSE** | **30 Marks-CA 120 Marks-EoSE** | **12 Marks-CA 48 Marks-EoSE** |

| Semester | Code of the Course | Title of the Course/Paper | | | | NHEQF Level | Credits |
|---|---|---|---|---|---|---|---|
| **I** | **UG0809-MAT-51T-151** | **Discrete Mathematics & Optimization Techniques-I** | | | | **5** | **6** |
| **Level of Course** | **Type of the Course** | **Credit Distribution** | | | **Offered to NC Student** | **Course Delivery Method** | |
| | | **Theory** | **Practical** | **Total** | | | |
| **Introductory** | **UG** | **6** | **0** | **6** | **No** | **Lecture, Ninety lectures** | |
| **List of Programme Codes in which Offered as Minor Discipline** | | | | | | | |
| **Prerequisites** | | Mathematics courses of XIIStd.ofCentral Board of Secondary Education or equivalent. | | | | | |
| **Objectives of the Course:** | | The objective of the course is to expose discrete structures and involve topology and optimization of real world problems. | | | | | |

## Detailed Syllabus

### [UG0809-MAT-51T-151] - [Discrete Mathematics & Optimization Techniques-I]

**Unit - I**

Relations on a set, Equivalence class, partial order relations, Chains and Anti-chains. Lattices, Distributive and Complemented Lattices. Boolean algebra, conjunctive normal form, disjunctive normal form. Principle of inclusion and exclusion. Propositional calculus, Basic logical operations, Truth tables, Tautologies and contradictions.

**(22 Lectures)**

**Unit -II**

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Discrete numeric functions, Generating functions, Recurrence relations, linear recurrence relation with constant coefficients and their solutions: Total solutions, Solution by the method of generating functions.Basic concepts of graph theory, Types of graphs, Walks, Paths & Circuits, Shortest path problem.

**(23 Lectures)**

**Unit -III**

Planar graphs, Operations on graphs (union, join, products). Matrix representation of graphs, Adjacency matrices, Incidence matrices. Hamiltonian and Eulerian graphs.Tree, Spanning tree, Minimum spanning tree, Distance between vertices, Center of tree, Binary tree, Rooted tree.

**(22 Lectures)**

**Unit-IV**

Linear programming problems. Feasible solution, Basic feasible solution. Some basic properties and theorems on convex sets. Simplex algorithm, Transportation problems. Assignment problems.

**(23 Lectures)**

## Suggested Books and References –


1. V.K.Balakrishnan, Introductory Discrete Mathematics, Prentice-Hall, 1996.
2. N. Deo, Graph Theory with Applications to Computer Science, Prentice-Hall of India.
3. C.L. Liu, Elements of Discrete Mathematics, (Second Edition), McGraw Hill, International Edition, 1986.
4. Kenneth H. Roson, Discrete Mathematics and Its Applications, Tata Mc-GrawHiils, New Delhi, 2003.
5. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.
6. Hamdy A. Taha, Operations Research, An Introduction (9th edition), Prentice-Hall, 2010.


## Suggested E-resources:

1. **Online Lecture Notes and Course Materials**

## Course Learning Outcomes:

The course would enable the student

1. To understand the ideas in discrete structures viz. Partially ordered sets, Lattices , Graphs etc. and allied conceptual intricacies with applications.
2. To understand mathematical formulation of optimization problems and allied theoretical concepts for solution methodologies for linear programming problems, Transportation problems assignment problems.

**Syllabus**
**[UG0809-Three/Four Year Bachelor of Science(Mathematics)] - [UG0809-MAT-51T-152] - [Number Theory]**
**I-Semester - [Mathematics]**

| Type | Paper code and Nomenclature | Duration of Examination | Maximum Marks (CA + EoSE) | Minimum Passing Marks (CA + EoSE) |
|---|---|---|---|---|
| Theory | UG0809-MAT-51T-152 Number Theory | 1 Hrs-CA 3 Hrs-EoSE | 30 Marks-CA 120 Marks-EoSE | 12 Marks-CA 48 Marks-EoSE |

| Semester | Code of the Course | Title of the Course/Paper | | | | NHEQF Level | Credits |
|---|---|---|---|---|---|---|---|
| I | UG0809-MAT-51T-152 | Number Theory | | | | 5 | 6 |
| Level of Course | Type of the Course | Credit Distribution | | | Offered to NC Student | Course Delivery Method | |
| | | Theory | Practical | Total | | | |
| Introductory | UG | 6 | 0 | 6 | No | Lecture, Ninety lectures | |
| List of Programme Codes in which Offered as Minor Discipline | | | | | | | |
| Prerequisites | | Mathematics courses of XII std. of Central Board of Secondary Education or equivalent. | | | | | |
| Objectives of the Course: | | The objective of the Course is to provide students with a comprehensive understanding of Euclidean algorithm, Congruence and Cryptography. | | | | | |

## Detailed Syllabus

## [UG0809-MAT-51T-152] - [Number Theory]

**Unit - I**

Divisibility – Division Algorithm, Divisibility in Z, g.c.d., the Euclidean algorithm,l.c.m., Primes, Infinitude of primes, Fundamental theorem of Arithmetic. Fibonacci sequence, Fibonacci numbers and their properties.

**(22 Lectures)**

**Unit -II**

Congruence – Linear conguruence, Chinese Remainder theorem, Fermat's Little theorem, Wilson's theorem, Fermat's factorization, Euler's factorization. Number theoretic functions: tau and sigma-functions, the Mobius function and inversion formula, Greatest integer function, Euler's phi function, Euler's generalization of Fermat's theorem. and the properties of phi function.

**(23 Lectures)**

**Unit -III**

Cryptography, Application of Number theory to Cryptography, Diophantine equations – $ax + by = c$, $ax + by + cz = d$, $x^2 + y^2 = z^2$, $x^4 + y^4 = z^2$, $x^4 + y^4 = z^4$, Fermat's last theorem.

**(22 Lectures)**

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**Unit-IV**

Quadratic congruence, Quadratic residues, Legendre symbol and its properties, Quadratic reciprocity. Order of an integer and its properties, Primitive roots for primes, Composite numbers having primitive roots, Theory of indices.

**(23 Lectures)**

**Suggested Books and References –**


1. S.Telang and M. Nadkarni, Number Theory, Tata McGraw-Hill, 2001.
2. David M. Burton, Elementary Number Theory (6th Edition), Tata McGraw-Hill Edition, Indian reprint, 2007.
3. I. Niven and H. Zukerman, An Introduction to the theory of Numbers, Wiley Eastern University Edition, New Delhi, 1985.
4. Neville Robinns, Beginning Number Theory (2nd Edition), Narosa Publishing House Pvt. Limited, Delhi, 2007.V.K.Balakrishnan, Introductory Discrete Mathematics, Prentice-Hall, 1996.


**Suggested E-resources:**

1. **Online Lecture Notes and Course Materials**

**Course Learning Outcomes:**

The course would enable the student

1. To apply Euclid's algorithm and Chinese Remainder Theorem.
2. To understand the definitions of congruences, residue classes and Application to Cryptography.
3. To apply number theoretic functions in various branches of mathematics.

## Syllabus
## [UG0809-Three/Four Year Bachelor of Science(Mathematics)] - [UG0809-MAT-52T-153 ] - [Calculus]
## II-Semester - [Mathematics]

| Type | Paper code and Nomenclature | Duration of Examination | Maximum Marks (CA + EoSE) | Minimum Passing Marks (CA + EoSE) |
|---|---|---|---|---|
| **Theory** | **UG0809-MAT-52T-153 Calculus** | **1 Hrs-CA 3 Hrs-EoSE** | **30 Marks-CA 120 Marks-EoSE** | **12 Marks-CA 48 Marks-EoSE** |

| Semester | Code of the Course | Title of the Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|

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| | | | | | | |
|---|---|---|---|---|---|---|
| **II** | **UG0809-MAT-52T-153** | **Calculus** | | | **5** | **6** |
| **Level of Course** | **Type of the Course** | **Credit Distribution** | | | **Offered to NC Student** | **Course Delivery Method** |
| | | **Theory** | **Practical** | **Total** | | |
| **Introductory** | **UG** | **6** | **0** | **6** | **No** | **Lecture, Ninety lectures** |
| **List of Programme Codes in which Offered as Minor Discipline** | | | | | | |
| **Prerequisites** | | Mathematics course of XII std. of Central Board of Secondary Education or equivalent. | | | | |
| **Objectives of the Course:** | | The objective of the course is to provide students with a comprehensive understanding of the fundamental concepts of calculus as a tool for dynamic systems, diverse topics find applications in many branches of science. | | | | |

## Detailed Syllabus

**[UG0809-MAT-52T-153 ] - [Calculus]**

**Unit - I**

Taylor's theorem. Maclaurin's theorem. Power series expansion of a function. Power series expansion of sin(x), cos(x), $e^x$, $\log_e(1+x)$, $(1+x)^n$. Derivative of the length of an arc. Pedal equations. Curvature: Various formulae, Centre of curvature and Chord of curvature.

**(22 Lectures)**

**Unit -II**

Partial differentiation. Euler's theorem for homogeneous functions. Chain rule of partial differentiation. Total differentiation, Differentiation of implicit functions. Envelopes: One parameter family of curves when two parameters are connected by a relation. Maxima and Minima of functions of two variables. Lagrange's method of undetermined multipliers.

**(23 Lectures)**

**Unit -III**

Asymptotes: Definition, Parallel to coordinate axes, General rational algebraic curves, inspection method, Intersection of a curve and its asymptotes. Multiple points. Curve tracing of Cartesian, Polar and parametric curves. Beta and Gamma functions.

**(22 Lectures)**

**Unit-IV**

Double integrals in Cartesian and Polar Coordinates, Change of order of integration. Triple integrals. Dirichlet's integral. Rectification, Area, Volume and Surface of solids of revolution.

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**(23 Lectures)**

**Suggested Books and References –**


1. Shanti Narayan and P.K. Mittal, Integral Calculus, S. Chand & Co., N. D., 2013.
2. H.S.Dhami, Differential Calculus, Age Int. Ltd., New Delhi, 2012.
3. M. J. Strauss, G. L. Bradley and K. J. Smith, Calculus (3rd Edition), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
4. H. Anton, I. Bivens and S. Davis, Calculus (7th Edition), John Wiley and sons (Asia), Pt Ltd., Singapore, 2002.
5. G.B. Thomas, R. L. Finney, M. D. Weir, Calculus and Analytic Geometry, Pearson Education Ltd, 2003.


**Suggested E-resources:**

1. **Online Lecture Notes and Course Materials:**

**Course Learning Outcomes:**

By the end of the course, students should be able to:

1. Understand the concept of curvature, padel equations, partial differentiation, envelope, asymptotes.
2. Understand the concept of maxima-minima, curve tracing, double and triple integration and their applications.

## Syllabus
## [UG0809-Three/Four Year Bachelor of Science(Mathematics)] - [UG0809-MAT-52T-154 ] - [Operations Research]
## II-Semester - [Mathematics]

| Type | Paper code and Nomenclature | Duration of Examination | Maximum Marks (CA + EoSE) | Minimum Passing Marks (CA + EoSE) |
|---|---|---|---|---|
| **Theory** | **UG0809-MAT-52T-154 Operations Research** | **1 Hrs-CA 3 Hrs-EoSE** | **30 Marks-CA 120 Marks-EoSE** | **12 Marks-CA 48 Marks-EoSE** |

| Semester | Code of the Course | Title of the Course/Paper | | | | NHEQF Level | Credits |
|---|---|---|---|---|---|---|---|
| **II** | **UG0809-MAT-52T-154** | **Operations Research** | | | | **5** | **6** |
| **Level of Course** | **Type of the Course** | **Credit Distribution** | | | **Offered to NC Student** | **Course Delivery Method** | |
| | | **Theory** | **Practical** | **Total** | | | |

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| | | | | | | |
|---|---|---|---|---|---|---|
| **Introductory** | **UG** | **6** | **0** | **6** | **No** | **Lecture, Ninety lectures** |
| **List of Programme Codes in which Offered as Minor Discipline** | | | | | | |
| **Prerequisites** | | Mathematics courses of XII std. of Central Board of Secondary Education or equivalent. | | | | |
| **Objectives of the Course:** | | The objective of the course is to enable students to learn concepts in optimization techniques viz. game theory, Inventory models, job sequencing and queueing theory. | | | | |

## Detailed Syllabus

## [UG0809-MAT-52T-154 ] - [Operations Research]

**Unit - I**

Inventory Models – Definitions, Types of inventory models, costs involved in inventory models, Classification of inventory models. Static demand models in Inventory control: EOQ models without shortage, EOQ models with shortage, limitations of EOQ formula, EOQ model with finite replenishment rate.

**(22 Lectures)**

**Unit -II**

Theory of Games – Introduction, Basic definitions, Minimax (Maximin) criterion and Optimal strategy. Solution of game with saddle point. Minimax-Maximin principle for mixed strategy games, Fundamental theorem of Game theory. Solution of 2X2 mixed strategy game. Solution of 2X2 mixed strategy game by the method of oddments. Dominance principle. Graphical method for solving 2Xn or mX2 game, Linear programming method for the solution of mXn game.

**(23 Lectures)**

**Unit -III**

Queueing Theory – Introduction, classification of queuing models. Distribution of arrivals. Distribution of inter-arrival time, Distribution of departures, Distribution of service time. Solution of queuing models: Model 1 (M/M/1): (∞/FCFS), Model 2 (M/M/1): (N/FCFS), Model 3 (M/M/C): (∞/FCFS), Model 4 (M/M/1): (N/FCFS).

**(22 Lectures)**

**Unit-IV**

Sequencing Models: Sequencing problems, processing n jobs through two machines. Processing n jobs through three machines, processing two jobs through m machines and processing n jobs through shortest cyclic Route Models. Minimal path problem (shortest Acyclic Route Models).

**(23 Lectures)**

**Suggested Books and References –**


1. J.K. Sharma, Operation research- Theory and Application, Macmillan Pub.India Ltd.


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2. KantiSwaroop, P.K.Gupta and Manmohan, Operation Research, Sultan Chand & . Chand & Co., N.D., 2007.
3. S.D.Sharma, Operations Research, KedarNath Ram NAth and co. Meerut, 2005.
4. F. S. Hillier and G. J. Lieberman, Introduction to Operations ResearchConcepts and Cases (9th Edition), Tata McGraw Hill, 2010.
5. Hamdy A. Taha, Operations Research, An Introduction (9th edition), Prentice-Hall, 2010.

**Suggested E-resources:**

1. **Online Lecture Notes and Course Materials:**

**Course Learning Outcomes:**

By the end of the course, students should be able to:

1. Analyze inventory models, costs, and constraints for efficient management.
2. Apply game theory principles to strategize and optimize outcomes.
3. Understand queuing theory and solve queuing models for various scenarios.
4. Master sequencing models for optimal task scheduling and job processing.
5. Apply replacement models for effective resource management and decision-making.

**Syllabus**
**[UG0809-Three/Four Year Bachelor of Science(Mathematics)] - [UG0809-MAT-63T-251] - [Real Analysis-I & Differential Equations-I]**
**III-Semester - [Mathematics]**

| Type | Paper code and Nomenclature | Duration of Examination | Maximum Marks (CA + EoSE) | Minimum Passing Marks (CA + EoSE) |
|---|---|---|---|---|
| Theory | UG0809-MAT-63T-251 Real Analysis-I & Differential Equations-I | 1 Hrs-CA 3 Hrs-EoSE | 20 Marks-CA 80 Marks-EoSE | 08 Marks-CA 32 Marks-EoSE |

| Semester | Code of the Course | Title of the Course/Paper | | | | NHEQF Level | Credits |
|---|---|---|---|---|---|---|---|
| III | UG0809-MAT-63T-251 | Real Analysis-I & Differential Equations-I | | | | 6 | 4 |
| Level of Course | Type of the Course | Credit Distribution | | | Offered to NC Student | Course Delivery Method | |
| | | Theory | Practical | Total | | | |
| Introductory | UG | 4 | 0 | 4 | No | Lecture, Sixty Lectures | |
| List of Programme Codes in which Offered as Minor Discipline | | | | | | | |
| Prerequisites | | Mathematics course of XII std. of Central Board of Secondary Education or equivalent. | | | | | |
| Objectives of the Course: | | The primary objective of this course is to introduce the real number with algebraic, order,completeness properties, and convergence/ divergence of sequences. The course also offers the solution strategies to differential equations viz. Linear, homogeneous linear, linear equations with constant coefficients and allied types. | | | | | |

## Detailed Syllabus

### [UG0809-MAT-63T-251 ] - [Real Analysis-I & Differential Equations-I]

**Unit - I**

Bounded set, Neighbourhood, Limit point, Bolzano-Weierstrass theorem, closed and Open sets. Concept of compactness and connectedness. Heine-Borel theorem.

**(15 Lectures)**

**Unit - II**

Real sequences- Limit and Convergence of a sequence, Monotonic sequences. Cauchy's sequences, Subsequences, Cauchy's general principle of convergence. Continuous functions: Properties of continuous functions on closed intervals.

**(15 Lectures)**

**Unit -III**

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Exact differential equations and equations which can be made exact. First order but higher degree differential equations solvable for x,y and p. Linear differential equations with constant coefficients, Complementary function and Particular integral.

**(15 Lectures)**

**Unit-IV**

Homogeneous linear differential equations, Linear differential equations of second order. Solution by transformation of the equation by changing the dependent variable/the independent variable, Method of variation of parameters, Method of undetermined coefficients.

**(15 Lectures)**

**Suggested Books and References –**


1. Royden H, Fitzpatrick PM. Real analysis. China Machine Press; 2010.
2. Rudin W. Principles of mathematical analysis. New York: McGraw-hill; 1964.
3. Bartle RG, Sherbert DR. Introduction to real analysis. New York: Wiley; 2000.
4. Mapa SK. Introduction to Real Analysis. Sarat Book Distributors; 2014.
5. Malik SC, Arora S. Mathematical analysis. New Age International; 1992.
6. Ross SL, Differential Equation-Jhon Wiley & Sons. Inc. New York. 1984.
7. Raisinghania MD, Ordinary and partial differential equations. S. Chand Publishing; 2013.


**Suggested E-resources:**

1. **Online Lecture Notes and Course Materials:**

**Course Learning Outcomes:**

By the end of the course, students should be able to:

1. Apply Bolzano-Weierstrass and Heine-Borel theorems to real number sets.
2. Test sequence convergence using Cauchy's principle and analyse continuous functions on closed intervals.
3. Solve first-order and higher-degree differential equations and linear differential equations with constant coefficients.
4. Solve second-order linear differential equations using transformation techniques and assess linear independence of solutions.

## Syllabus
## [UG0809-Three/Four Year Bachelor of Science(Mathematics)] - [UG0809-MAT-63P-252] - [Introduction to Scilab: A Mathematical Tool]
## III-Semester - [Mathematics]

| Type | Paper code and Nomenclature | Duration of Examination | Maximum Marks (CA + EoSE) | Minimum Passing Marks (CA + EoSE) |
|---|---|---|---|---|
| **Practical** | **UG0809-MAT-63P-252 Introduction to Scilab: A Mathematical Tool** | **2 Hrs-CA 3 Hrs-EoSE** | **10 Marks-CA 40 Marks-EoSE** | **04 Marks-CA 16 Marks-EoSE** |

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| Semester | Code of the Course | Title of the Course/Paper | | | | NHEQF Level | Credits |
|---|---|---|---|---|---|---|---|
| III | UG0809-MAT-63P-252 | Introduction to Scilab: A Mathematical Tool | | | | 6 | 2 |
| Level of Course | Type of the Course | Credit Distribution | | | Offered to NC Student | Course Delivery Method | |
| | | Theory | Practical | Total | | | |
| Introductory | UG | 0 | 2 | 2 | No | Practical, Sixty Hours of Practical | |
| List of Programme Codes in which Offered as Minor Discipline | | | | | | | |
| Prerequisites | | Mathematics course of XII std. of Central Board of Secondary Education or equivalent. | | | | | |
| Objectives of the Course: | | The objective of the course is to equip students with skills to create, analyze, and understand graphs. To teach the use of computational and programming functions with Scilab. To understand and apply methods for solving linear equations and other mathematical problems. | | | | | |

## Detailed Syllabus

## [UG0809-MAT-63P-252] - [Introduction to Scilab: A Mathematical Tool]

***Group-A***

1. Plotting the graphs of the following functions ax, $\sqrt{(ax+b)}$, $|ax+b|$, $c \pm |ax+b|$, $x^{\pm n}$, $e^{ax+b}$, $\log(ax+b)$, $\sin(ax+b)$, $\cos(ax+b)$, $|\sin(ax+b)|$, $|\cos(ax+b)|$. explaining the effects of change in the real constant a, b and c on graphs. Plotting graphs of hyperbolic functions and inverse trigonometric functions, plotting and analyzing the graphs of polynomials and their derivatives.
2. Complex numbers: Operations like addition, subtraction, multiplication, division, Modulus and inbuilt functions conj, imag, imult, isreal, real.

**(20 Hours)**

***Group-B***

1. Matrix operations: addition, multiplication, inverse, transpose, determinant, rank and inbuilt functions eye, ones, zeros. Solving the system of linear equations by using Matrix Division (\ Operator), using 'linsolve' function, using 'inv' function, using 'mldivide' function.
2. Finding Roots of equations by using 'fsolve' function, using 'roots' function, using 'mnewton' function.

**(20 Hours)**

***Group-C***

1. Solving linear programming problems by using inbuilt functions of Scilab.

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2. Solving Ordinary Differential Equations (ODEs) by using the 'ode' function.

**(20 Hours)**

**Suggested Books and References –**


1. Sandeep Nagar, Introduction to Scilab: For Engineers and Scientists, APress; 1st ed. Edition.
2. Claude Gomez, Engineering and Scientific Computing with Scilab, Birkhauser Boston Inc; 1999th edition.
3. Tejas Sheth, Scilab: A Practical Introduction to Programming and Problem Solving, Createspace Independent Pub.


**Suggested E-resources:**

1. **Online Lecture Notes and Course Materials**

**Course Learning Outcomes:**

By the end of the course, students should be able to:

1. Understand graphical and numerical techniques and their execution on Scilab.
2. Students should gain practical expertise in solving problems involving graphs, matrices, and equations.
3. Students should be prepared to utilise various mathematical techniques to solve different mathematical problems.

## Syllabus
## [UG0809-Three/Four Year Bachelor of Science(Mathematics)] - [UG0809-MAT-63T-253] - [Mathematical Statistics]
## III-Semester - [Mathematics]

| Type | Paper code and Nomenclature | Duration of Examination | Maximum Marks (CA + EoSE) | Minimum Passing Marks (CA + EoSE) |
|---|---|---|---|---|
| **Theory** | **UG0809-MAT-63T-253 Mathematical Statistics** | **1 Hrs-CA 3 Hrs-EoSE** | **30 Marks-CA 120 Marks-EoSE** | **12 Marks-CA 48 Marks-EoSE** |

| Semester | Code of the Course | Title of the Course/Paper | | | | NHEQF Level | Credits |
|---|---|---|---|---|---|---|---|
| **III** | **UG0809-MAT-63T-253** | **Mathematical Statistics** | | | | **6** | **6** |
| **Level of Course** | **Type of the Course** | **Credit Distribution** | | | **Offered to NC Student** | **Course Delivery Method** | |
| | | **Theory** | **Practical** | **Total** | | | |
| **Introductory** | **UG** | **6** | **0** | **6** | **No** | **Lecture, Ninety lectures** | |

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| | |
|---|---|
| **List of Programme Codes in which Offered as Minor Discipline** | |
| **Prerequisites** | Mathematics course of XII std. of Central Board of Secondary Education or equivalent. |
| **Objectives of the Course:** | The main objective of this course is to introduce the theory underlying modern statistics to give the student a solid grounding in Mathematical Statistics. |

## Detailed Syllabus

## [UG0809-MAT-63T-253] - [Mathematical Statistics]

**Unit - I**

Frequency distributions and measures of location, Measures of dispersion, Skewness and Kurtosis, Moments of frequency distributions.

**(22 Lectures)**

**Unit - II**

Theory of probability. Mathematical expectation, Moment generating and Cumulative functions.

**(23 Lectures)**

**Unit -III**

Discrete probability distributions (Binomial, Poisson, Geometric and Hypergeometric). Continuous probability distributions (Rectangular and Normal distributions).

**(22 Lectures)**

**Unit-IV**

Methods of least squares and curve fitting. Correlation and Regression.

**(23 Lectures)**

**Suggested Books and References –**


1. Gupta SC, Kapoor VK. Fundamentals of mathematical statistics. Sultan Chand & Sons; 2020.
2. Kapur JN, Saxena HC. Mathematical Statistics. S. Chand; 1976.
3. Meyer PL. Introductory probability and statistical applications. Oxford and IBH Publishing; 1965.
4. Spiegel MR, Srinivasan RA, Schiller JJ. Schaum's outline of theory and problems of probability and statistics. Erlangga; 2000.
5. Goon AM, Gupta MK, Dasgupta B. Fundamentals of Statistics. World Press Private Limited; 1975.


**Suggested E-resources:**

1. **Online Lecture Notes and Course Materials:**

**Course Learning Outcomes:**

By the end of the course, students should be able to:

1. Analyse frequency distributions and measure central tendency, dispersion, skewness, and kurtosis.
2. Apply probability theory, mathematical expectation, and moment generating functions.

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3. Use discrete and continuous probability distributions in practical scenarios.
4. Implement least squares, curve fitting, and correlation and regression techniques.

## Syllabus
## [UG0809-Three/Four Year Bachelor of Science(Mathematics)] - [UG0809-MAT-64T-254] - [Real Analysis-II & Numerical Analysis ]
## IV-Semester - [Mathematics]

| Type | Paper code and Nomenclature | Duration of Examination | Maximum Marks (CA + EoSE) | Minimum Passing Marks (CA + EoSE) |
|---|---|---|---|---|
| **Theory** | **UG0809-MAT-64T-254 Real Analysis-II & Numerical Analysis** | **1 Hrs-CA 3 Hrs-EoSE** | **20 Marks-CA 80 Marks-EoSE** | **08 Marks-CA 32 Marks-EoSE** |

| Semester | Code of the Course | Title of the Course/Paper | | | | NHEQF Level | Credits |
|---|---|---|---|---|---|---|---|
| **IV** | **UG0809-MAT-64T-254** | **Real Analysis-II & Numerical Analysis** | | | | **6** | **4** |
| **Level of Course** | **Type of the Course** | **Credit Distribution** | | | **Offered to NC Student** | **Course Delivery Method** | |
| | | **Theory** | **Practical** | **Total** | | | |
| **Introductory** | **UG** | **4** | **0** | **4** | **No** | **Lecture, Sixty Lectures** | |
| **List of Programme Codes in which Offered as Minor Discipline** | | | | | | | |
| **Prerequisites** | | **UG0809-MAT-63T-251 Real Analysis-I & Differential Equations-I** | | | | | |
| **Objectives of the Course:** | | The primary objective of this course is to enable students to understand fundamental concepts of differentiable functions, apply Darboux's, Rolle's theorems, Riemann integration, mean value theorems, and to learn numerical techniques viz interpolation, Numerical integration, roots of equation, solution of initial value problem. | | | | | |

## Detailed Syllabus

## [UG0809-MAT-64T-254] - [Real Analysis-II & Numerical Analysis ]

**Unit - I**

Properties of derivable functions, Darboux's and Rolle's theorem. Notion of limit, continuity and differentiability for functions of two variables. Directional derivative, total derivative, expression of total derivative in terms of partial derivatives.

**(15 Lectures)**

**Unit - II**

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Riemann integration – Lower and Upper Riemann integrals, Riemann integrability, Mean value theorems of integral calculus, Fundamental theorem of integral calculus. Functions of bounded variations.

**(15 Lectures)**

**Unit -III**

Differences. Relation between differences and derivatives. Differences of a polynomial. Newton's formula for forward and backward interpolation. Divided differences. Newton's divided difference, Lagrange's interpolation formula. Numerical Differentiation. Derivatives from interpolation formulae.

**(15 Lectures)**

**Unit-IV**

Numerical integration, Derivations of general quadrature formulas, Trapezoidal rule. Simpson's one-third, Simpson's three-eighth and Gauss's quadrature formulae. Numerical solution of Algebraic and Transcendental equations: Bisection method, Secant method, Regula-Falsi method, Iteration method, Newton- Raphson Method. Numerical solutions of ordinary differential equations of first order with initial condition using Euler and modified Euler's method.

**(15 Lectures)**

**Suggested Books and References –**


1. Royden H, Fitzpatrick PM. Real analysis. China Machine Press; 2010.
2. Rudin W. Principles of mathematical analysis. New York: McGraw-hill; 1964.
3. Bartle RG, Sherbert DR. Introduction to real analysis. New York: Wiley; 2000.
4. Mapa SK. Introduction to Real Analysis. Sarat Book Distributors; 2014.
5. Malik SC, Arora S. Mathematical analysis. New Age International; 1992.
6. Burden RL, Faires JD. Numerical analysis, brooks;1997.
7. Iyengar SR, Jain RK. Numerical Methods. New Age International; 2009.
8. Sastry SS. Introductory methods of numerical analysis. PHI Learning Pvt. Ltd.; 2012.


**Suggested E-resources:**

1. **Online Lecture Notes and Course Materials:**

**Course Learning Outcomes:**

By the end of the course, students should be able to:

1. Analyse multivariable functions using differentiability and partial derivatives.
2. Solve problems using Riemann integrability and integral calculus theorems.
3. Use interpolation formulas for data approximation and numerical differentiation.
4. Apply numerical methods to solve equations and differential equations.

**Syllabus**
**[UG0809-Three/Four Year Bachelor of Science(Mathematics)] - [UG0809-MAT-64P-255] - [Introduction to C Programming: As Mathematical Tool ]**
**IV-Semester - [Mathematics]**

| Type | Paper code and Nomenclature | Duration of Examination | Maximum Marks (CA + EoSE) | Minimum Passing Marks (CA + EoSE) |
|---|---|---|---|---|
| **Practical** | **UG0809-MAT-64P-255 Introduction to C Programming: As Mathematical Tool** | **2 Hrs-CA 3 Hrs-EoSE** | **10 Marks-CA 40 Marks-EoSE** | **04 Marks-CA 16 Marks-EoSE** |

| Semester | Code of the Course | Title of the Course/Paper | | | | NHEQF Level | Credits |
|---|---|---|---|---|---|---|---|
| **IV** | **UG0809-MAT-64P-255** | **Introduction to C Programming: As Mathematical Tool** | | | | **6** | **2** |
| **Level of Course** | **Type of the Course** | **Credit Distribution** | | | **Offered to NC Student** | **Course Delivery Method** | |
| | | **Theory** | **Practical** | **Total** | | | |
| **Introductory** | **UG** | **0** | **2** | **2** | **No** | **Practical, Sixty Hours of Practical** | |
| **List of Programme Codes in which Offered as Minor Discipline** | | | | | | | |
| **Prerequisites** | | Mathematics course of XII std. of Central Board of Secondary Education or equivalent. | | | | | |
| **Objectives of the Course:** | | The objective of the course is to enable students learn the basic knowledge of developing algorithms for various Mathematical problems and preparing codes for these algorithms in C language. | | | | | |

## Detailed Syllabus

## [UG0809-MAT-64P-255] - [Introduction to C Programming: As Mathematical Tool ]

Programming languages and problem solving on computers, Algorithm, Flow chart, Programming in C-Constants, Variables, Arithmetic and logical expressions, Input-Output, Conditional statements, Implementing loops in Programs, Defining and manipulating arrays and functions.

***Group-A***

1. Printing n terms of Fibonacci sequence and finding factorial n, summation n, summation of square of n etc.
2. Defining a function and finding sum of n terms of a series/sequence whose general term is given.
3. Finding gcd and lcm of two numbers by Euclid's algorithm.
4. Checking prime/composite numbers and finding the number of primes less than n, where n is a positive integer.

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5. Finding mean, standard deviation and Permutation, Combination.

**(20 Hours)**

***Group-B***

6. Numerical integration using Trapezoidal rule.
7. Numerical integration using Simpson's ⅓ rule.
8. Numerical integration using Simpson's 3/8 rule.
9. Numerical integration using Waddle rules.
10. Preparing forward and backward difference tables.

**(20 Hours)**

***Group-C***

11. Solution of algebraic and transcendental equations by Bisection method.
12. Solution of algebraic and transcendental equations by Regula-falsi method.
13. Solution of algebraic and transcendental equations by Newton-Raphson method.
14. Solution of Initial value problems by Euler's method.
15. Solution of Initial value problems by Runga-Kutta fourth order method.

**(20 Hours)**

**Suggested Books and References –**


1. B. W. Kernighan and D. M. Ritchi : The C-Programming Language, 2nd Edi.(ANSI Refresher), Prentice Hall, 1977.
2. E. Balagurnsamy : Programming in ANSI C, Tata McGraw Hill, 2004.
3. Y. Kanetkar : Let Us C ; BPB Publication, 1999.
4. C. Xavier : C-Language and Numerical Methods, New Age International, 2007.
5. V. Rajaraman : Computer Oriented Numerical Methods, Prentice Hall of India, 1980.


**Suggested E-resources:**

1. **Online Lecture Notes and Course Materials:**

**Course Learning Outcomes:**

By the end of the course, students should be able to:

1. Understand the logic for a given problem.
2. Write the algorithm of a given problem.
3. Draw a flow chart of a given problem.
4. Recognize and understand the syntax and construction of C programming code.

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## Syllabus
## [UG0809-Three/Four Year Bachelor of Science(Mathematics)] - [UG0809-MAT-64T-256] - [Advanced Analysis]
## IV-Semester - [Mathematics]

| Type | Paper code and Nomenclature | Duration of Examination | Maximum Marks (CA + EoSE) | Minimum Passing Marks (CA + EoSE) |
|---|---|---|---|---|
| Theory | UG0809-MAT-64T-256 Advanced Analysis | 1 Hrs-CA<br>3 Hrs-EoSE | 30 Marks-CA<br>120 Marks-EoSE | 12 Marks-CA<br>48 Marks-EoSE |

| Semester | Code of the Course | Title of the Course/Paper | | | | NHEQF Level | Credits |
|---|---|---|---|---|---|---|---|
| IV | UG0809-MAT-64T-256 | Advanced Analysis | | | | 6 | 6 |
| Level of Course | Type of the Course | Credit Distribution | | | Offered to NC Student | Course Delivery Method | |
| | | Theory | Practical | Total | | | |
| Introductory | UG | 6 | 0 | 6 | No | Lecture, Ninety lectures | |
| List of Programme Codes in which Offered as Minor Discipline | | | | | | | |
| Prerequisites | | UG0809-MAT-63T-251<br>Real Analysis-I & Differential Equations-I | | | | | |
| Objectives of the Course: | | This course aims to equip students with advanced mathematical tools and analytical skills necessary for tackling real-world problems in mathematics, physics, engineering, and related fields. | | | | | |

## Detailed Syllabus

## [UG0809-MAT-64T-256] - [Advanced Analysis]

### Unit - I

Calculus of Variations- Variation and its properties. Euler's equation. Functionals. Functionals dependent on Higher order derivatives and functions of several independent variables. Variational problems in parametric form. The moving boundary value problem for a function of the form $\int_{x_1}^{x_2} f(x,y,z)dx$. Euler's finite difference method. Ritz method for variational problem.

**(22 Lectures)**

### Unit - II

Sequence and series of functions – Pointwise and Uniform convergence, Cauchy's criterion, Weierstrass M-test, Abel's test, Dirichlet's test for uniform convergence of series of functions, Uniform convergence and Continuity of series of functions, Term by term differentiation and integration.

**(23 Lectures)**

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**Unit -III**

Metric space – Definition and examples, Open and Closed sets, Interior and Closure of a set, Limit point of a set in metric space.

**(22 Lectures)**

**Unit-IV**

Compact metric space. Connected metric space.

**(23 Lectures)**

**Suggested Books and References –**


1. Royden H, Fitzpatrick PM. Real analysis. China Machine Press; 2010.
2. Rudin W. Principles of mathematical analysis. New York: McGraw-hill; 1964.
3. Bartle RG, Sherbert DR. Introduction to real analysis. New York: Wiley; 2000.
4. Mapa SK. Introduction to Real Analysis. Sarat Book Distributors; 2014.
5. Malik SC, Arora S. Mathematical analysis. New Age International; 1992.
6. Kumaresan S. Topology of metric spaces. Alpha Science Int'l Ltd.; 2005.
7. Gupta AS. Calculus of variations with applications. PHI Learning Pvt. Ltd.; 1996.


**Suggested E-resources:**

1. **Online Lecture Notes and Course Materials:**

**Course Learning Outcomes:**

By the end of the course, students should be able to:

1. Solve variational problems using Euler's equation and numerical methods.
2. Ensure series of functions converge uniformly using appropriate convergence tests.
3. Analyze metric space properties including open sets and limit points.
4. Apply compactness and connectedness concepts in metric spaces to practical scenarios.

## Syllabus
## [UG0809-Three/Four Year Bachelor of Science(Mathematics)] - [UG0809-MAT-75T-351] - [Abstract Algebra & Three Dimensional Geometry]
## V-Semester - [Mathematics]

| Type | Paper code and Nomenclature | Duration of Examination | Maximum Marks (CA + EoSE) | Minimum Passing Marks (CA + EoSE) |
|---|---|---|---|---|
| **Theory** | **UG0809-MAT-75T-351 Abstract Algebra & Three Dimensional Geometry** | **1 Hrs-CA 3 Hrs-EoSE** | **30 Marks-CA 120 Marks-EoSE** | **12 Marks-CA 48 Marks-EoSE** |

| Semester | Code of the Course | Title of the Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|

| V | UG0809-MAT-75T-351 | Abstract Algebra & Three Dimensional Geometry | | | 7 | 6 |
|---|---|---|---|---|---|---|
| **Level of Course** | **Type of the Course** | **Credit Distribution** | | | **Offered to NC Student** | **Course Delivery Method** |
| | | **Theory** | **Practical** | **Total** | | |
| **Introductory** | **UG** | **6** | **0** | **6** | **No** | **Lecture, Ninety lectures** |
| **List of Programme Codes in which Offered as Minor Discipline** | | | | | | |
| **Prerequisites** | | Mathematics course of XII std. of Central Board of Secondary Education or equivalent. | | | | |
| **Objectives of the Course:** | | The objective of the course on Group Theory, Ring Theory, and three dimensional geometry, as outlined in the syllabus, is to provide students with a thorough understanding of fundamental algebraic structures, their applications and basic three dimensional geometrical shapes. | | | | |

## Detailed Syllabus

## [UG0809-MAT-75T-351] - [Abstract Algebra & Three Dimensional Geometry]

**Unit - I**

Binary operations, Algebraic structure, Groups, Order of group, finite and infinite order groups and their order specific theorems, Subgroups and their properties, Permutation group, Cyclic group. Cosets, Lagrange's theorem.

**(22 Lectures)**

**Unit - II**

Morphism of groups, Cayley's theorem. Normal subgroups and Quotient groups. Fundamental theorems of Homomorphism.

**(23 Lectures)**

**Unit -III**

Definition and simple properties of Rings and Subrings. Morphism of rings. Integral domain and field. Characteristics of a Ring and Field.

**(22 Lectures)**

**Unit-IV**

Sphere: Equation of Sphere, Plane section of sphere, intersection of a sphere by a line, tangent line and tangent plane of a sphere, angle of intersection of two spheres. Cone: Equation of cone, tangent plane of a cone, right circular cone, enveloping cone. Cylinder: Equation of cylinder, enveloping cylinder, right circular cylinder.

**(23 Lectures)**

**Suggested Books and References –**

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1. Kenneth Hoffman, Ray Alden Kunze, Linear Algebra 2nd Ed., Prentice-Hall Of India Pvt. Limited, 1971.
2. I.N.Herstein, Topics in Algebra, Wiley-Eastern Ltd., New Delhi.
3. Joseph A. Gallian, Contemporary Abstract Algebra (4th Edition), Narosa Publishing House, New Delhi, 1999.(IX Edition 2010).
4. N.S.Gopalkrishnan, University Algebra, New Age International, 1986.
5. G.C.Sharma, Modern Algebra, Shivlal Agrawal & Co., Agra,1998.
6. S.L. Loney, The Elements of Coordinate Geometry, Macmillan and co. London, 1895.
7. R.J.T. Bell, Elementary Treatise on Co-ordinate geometry of three dimensions, Macmillan India Ltd., 1994.

**Suggested E-resources:**

1. **Online Lecture Notes and Course Materials:**

**Course Learning Outcomes:**

By the end of the course, students should be able to:

1. Develop a theoretical foundation in algebraic structures including groups, rings,integral domains and fields.
2. Apply theoretical concepts to solve problems involving group theory and ring theory.
3. Analyze and differentiate algebraic structures and their interrelations.
4. Understand the applications of algebraic structures in various mathematical and scientific disciplines.

## Syllabus
## [UG0809-Three/Four Year Bachelor of Science(Mathematics)] - [UG0809-MAT-75T-352] - [Optimization Techniques-II]
## V-Semester - [Mathematics]

| Type | Paper code and Nomenclature | Duration of Examination | Maximum Marks (CA + EoSE) | Minimum Passing Marks (CA + EoSE) |
|---|---|---|---|---|
| **Theory** | **UG0809-MAT-75T-352 Optimization Techniques-II** | **1 Hrs-CA 3 Hrs-EoSE** | **30 Marks-CA 120 Marks-EoSE** | **12 Marks-CA 48 Marks-EoSE** |

| Semester | Code of the Course | Title of the Course/Paper | | | | NHEQF Level | Credits |
|---|---|---|---|---|---|---|---|
| **V** | **UG0809-MAT-75T-352** | **Optimization Techniques-II** | | | | **7** | **6** |
| **Level of Course** | **Type of the Course** | **Credit Distribution** | | | **Offered to NC Student** | **Course Delivery Method** | |
| | | **Theory** | **Practical** | **Total** | | | |
| **Introductory** | **UG** | **6** | **0** | **6** | **No** | **Lecture, Ninety lectures** | |
| **List of Programme Codes in which Offered as Minor Discipline** | | | | | | | |

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| | |
|---|---|
| **Prerequisites** | **UG0809-MAT-51T-151**<br>**Discrete Mathematics & Optimization Techniques-I** |
| **Objectives of the Course:** | The objective of the course "Optimization Techniques-II" with the outlined syllabus is to equip students with a comprehensive understanding and practical skills in solving optimization problems using advanced mathematical techniques. |

## Detailed Syllabus

## [UG0809-MAT-75T-352] - [Optimization Techniques-II]

**Unit - I**

Theory of Simplex method, two phase method, bounded variables problems in linear programming, The Dual Simplex method.

**(22 Lectures)**

**Unit - II**

Duality in linear programming: Concept of duality, General rules for converting any primal into its dual, Duality theorems, primal-dual correspondence, rules for obtaining dual optimal solution from that of primal and primal optimal solution from the dual.

**(23 Lectures)**

**Unit -III**

Integer linear programming: Definitions, Gomory's all integer programming technique: Construction of Gomory's constraint, Gomory's cutting plane algorithm for all integer programming problems, Branch and Bound method: Branch and bound algorithm and its geometrical interpretation.

**(22 Lectures)**

**Unit-IV**

Sensitivity analysis: Introduction, changes in the coefficients '$c_j$' of the objective function, changes in the component '$b_i$' of vector **b,** changes in the component '$a_{ij}$' of matrix ***A***. Revised Simplex method: Introduction, Revised Simplex algorithm when artificial variables are not needed.

**(23 Lectures)**

**Suggested Books and References –**


1. Kanti Swaroop, P.K.Gupta and Manmohan, Operation Research, Sultan Chand & Sons., N.Delhi, 2007.
2. S.D.Sharma, Operations Research, Kedar Nath Ram Nath and co. Meerut, 2005.
3. F. S. Hillier and G. J. Lieberman, Introduction to Operations Research Concepts and Cases (9th Edition), Tata McGraw Hill, 2010.
4. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.
5. Hamdy A. Taha, Operations Research, An Introduction (9th edition), Prentice-Hall, 2010.


**Suggested E-resources:**

1. **Online Lecture Notes and Course Materials:**

**Course Learning Outcomes:**

By the end of the course, students should be able to:

1. Understand and apply the simplex method, two-phase method, and the dual simplex method to solve linear programming problems with bounded variables.
2. Grasp Duality concepts and solve Integer Programming Problems.
3. Perform Sensitivity analysis and utilise Revised Simplex method.

## Syllabus
## [UG0809-Three/Four Year Bachelor of Science(Mathematics)] - [UG0809-MAT-76T-353 ] - [Complex Analysis & Mechanics]
## VI-Semester - [Mathematics]

| Type | Paper code and Nomenclature | Duration of Examination | Maximum Marks (CA + EoSE) | Minimum Passing Marks (CA + EoSE) |
|---|---|---|---|---|
| **Theory** | **UG0809-MAT-76T-353 Complex Analysis & Mechanics** | **1 Hrs-CA 3 Hrs-EoSE** | **30 Marks-CA 120 Marks-EoSE** | **12 Marks-CA 48 Marks-EoSE** |

| Semester | Code of the Course | Title of the Course/Paper | | | | NHEQF Level | Credits |
|---|---|---|---|---|---|---|---|
| **VI** | **UG0809-MAT-76T-353** | **Complex Analysis & Mechanics** | | | | **7** | **6** |
| **Level of Course** | **Type of the Course** | **Credit Distribution** | | | **Offered to NC Student** | **Course Delivery Method** | |
| | | **Theory** | **Practical** | **Total** | | | |
| **Introductory** | **UG** | **6** | **0** | **6** | **No** | **Lecture, Ninety lectures** | |
| **List of Programme Codes in which Offered as Minor Discipline** | | | | | | | |
| **Prerequisites** | | Mathematics course of XII std. of Central Board of Secondary Education or equivalent. | | | | | |
| **Objectives of the Course:** | | The objective of the course is to enable students to understand and apply complex analysis, principles of equilibrium and work, and solve mechanical problems. | | | | | |

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## Detailed Syllabus

## [UG0809-MAT-76T-353] - [Complex Analysis & Mechanics]

**Unit - I**

Complex valued function: Limits, Continuity and Differentiability. Analytic functions, Cauchy-Riemann equations. Harmonic functions, Construction of an analytic function. Complex integration, Complex line integrals, Cauchy integral theorem, Indefinite integral, Fundamental theorem of integral calculus for complex functions. Cauchy integral formula, Analyticity of the derivative of an analytic function.

**(22 Lectures)**

**Unit - II**

Taylor's theorem. Laurent's theorem. Maximum modulus theorem. Singularities of an analytic function, Branch point, Meromorphic and Entire functions, Residue at a singularity, Cauchy's residue theorem.

**(23 Lectures)**

**Unit -III**

Velocity and acceleration – along radial and transverse directions, along tangential and normal directions, Motion in resisting medium – Resistance varies as velocity and square of velocity, Motion on a smooth curve in a vertical plane.

**(22 Lectures)**

**Unit-IV**

Equilibrium of coplanar forces, moments, Friction,Virtual Work and catenary.

**(23 Lectures)**

**Suggested Books and References –**


1. Brown JW, Churchill RV. Complex variables and applications. McGraw-Hill,; 2009.
2. Kasana HS. Complex variables: theory and applications. PHI Learning Pvt. Ltd.; 2005.
3. Ponnusamy S, Silverman H. Complex variables with applications. Springer Science & Business Media; 2007.
4. A.S.Ramsey, Statics, CBS Publishing & Distributors, New Delhi.
5. M. Ray, A Text Book of Dynamics, S. Chand & Co., 2003.
6. J.L. Synge & B.A. Griffith - Principles of Mechanics, Tata McGraw-Hill, 1959.
7. R.C. Hibbeler and Ashok Gupta, Engineering Mechanics: Statics and Dynamics (11th Edition), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi.


**Suggested E-resources:**

1. **Online Lecture Notes and Course Materials:**

**Course Learning Outcomes:**

By the end of the course, students would have achieved the following:

1. Grasped the concepts of Taylor's and Laurent's theorems as they apply to complex functions.
2. Conducted analysis on the singularities of analytic functions, including branch points, meromorphic

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functions, entire functions, and residues at singularities using the Cauchy residue theorem.

3. Understand and calculate velocity and acceleration in various directions and analyze motion in resisting media.
4. Analyze the equilibrium of coplanar forces, calculate moments, and understand the effects of friction.
5. Apply the principles of virtual work to mechanical systems and analyze motion on smooth curves in vertical planes.
6. Mathematical treatment to the configuration called catenary.

## Syllabus
## [UG0809-Three/Four Year Bachelor of Science(Mathematics)] - [UG0809-MAT-76T-354 ] - [Linear Algebra & Differential Equations-II]
## VI-Semester - [Mathematics]

| Type | Paper code and Nomenclature | Duration of Examination | Maximum Marks (CA + EoSE) | Minimum Passing Marks (CA + EoSE) |
|---|---|---|---|---|
| **Theory** | **UG0809-MAT-76T-354 Linear Algebra & Differential Equations-II** | **1 Hrs-CA 3 Hrs-EoSE** | **30 Marks-CA 120 Marks-EoSE** | **12 Marks-CA 48 Marks-EoSE** |

| Semester | Code of the Course | Title of the Course/Paper | | | | NHEQF Level | Credits |
|---|---|---|---|---|---|---|---|
| **VI** | **UG0809-MAT-76T-354** | **Linear Algebra & Differential Equations-II** | | | | **7** | **6** |
| **Level of Course** | **Type of the Course** | **Credit Distribution** | | | **Offered to NC Student** | **Course Delivery Method** | |
| | | **Theory** | **Practical** | **Total** | | | |
| **Introductory** | **UG** | **6** | **0** | **6** | **No** | **Lecture, Ninety lectures** | |
| **List of Programme Codes in which Offered as Minor Discipline** | | | | | | | |
| **Prerequisites** | | **UG0809-MAT-63T-251 Real Analysis-I & Differential Equations-I and UG0809-MAT-75T-351 Abstract Algebra & Three Dimensional Geometry** | | | | | |
| **Objectives of the Course:** | | The objective of the course is to provide students with a foundation in the theory of vector spaces, linear transformations and to teach them the theory and methods for solving first-order PDEs. | | | | | |

## Detailed Syllabus

## [UG0809-MAT-76T-354] - [Linear Algebra & Differential Equations-II]

**Unit - I**

Introduction to Vector Spaces, Subspaces, Algebra of subspaces, Linear combination of vectors, Linear span, Linear independence, Bases and dimension, Dimension of subspaces. Linear and direct sum of subspaces.

**(22 Lectures)**

**Unit - II**

Linear transformations, Null space, Range, Rank and nullity of a linear transformation, Matrix representation of a linear transformation, Algebra of linear transformations, Invertibility and isomorphisms.

**(23 Lectures)**

**Unit -III**

Partial differential equations of the first order, Lagrange's linear equation, Non-linear partial differential equations of order one : various standard forms, Charpit's method.

**(22 Lectures)**

**Unit-IV**

Homogeneous and non-homogeneous linear partial differential equations with constant coefficients. Equations reducible to linear partial differential equations with constant coefficients.

**(23 Lectures)**

**Suggested Books and References –**


1. Sahai V, Bist V. Linear algebra. Alpha Science Int'l Ltd.; 2002.
2. Lipschutz S, Lipson M. Schaum's outline of theory and problems of linear algebra. Erlangga; 2001.
3. Spence LE, Insel AJ, Friedberg SH. Elementary Linear Algebra: A Matrix Approach. (No Title). 2008.
4. M.D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand & Co., 2003.
5. M.Ray, A Text Book on Differential Equations, Students and Friends Co., Agra,1998.
6. I.N. Snedon, Elements of Partial Differential Equations, TMH, 2001.


**Suggested E-resources:**

1. **Online Lecture Notes and Course Materials:**

**Course Learning Outcomes:**

By the end of the course, students should be able to:

1. Apply theoretical concepts to solve complex problems involving vector spaces, linear transformations, and PDEs.
2. Connect abstract concepts from linear algebra to practical problems in engineering, physics, and other fields.
3. Develop a deeper understanding of the structure and properties of mathematical systems and their interrelationships.