

NEP: UGCF 2022
B.Sc. (Hons.) Mathematics
Syllabi and Books for
Discipline-Specific Core & Elective Courses
Semester-III
JULY 2024

Syllabi (Source File):
[06062023_87_notification_MathSC.pdf](#)

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(The books are hosted on [GitHub](#) and [Drive](#))

Depending on the features of the cited PDF file, either the PDF viewer or the Browser may be invoked.

DSC-VII
GROUP THEORY

Unit-I Permutation Groups, Lagrange's Theorem and Normal Subgroups

- ◆ Permutation groups and group of symmetries ◆ Cycle notation for permutations and properties
- ◆ Even and odd permutations ◆ Alternating groups ◆ Cosets and its properties
- ◆ Lagrange's theorem and consequences including Fermat's Little theorem
- ◆ Number of elements in product of two finite subgroups ◆ Normal subgroups ◆ Factor groups
- ◆ Cauchy's theorem for finite Abelian groups

Unit-II Group Homomorphisms and Automorphisms

- ◆ Group homomorphisms, isomorphisms and properties ◆ Cayley's theorem
- ◆ First, Second and Third isomorphism theorems for groups ◆ Automorphism
- ◆ Inner automorphism ◆ Automorphism groups ◆ Automorphism groups of cyclic groups
- ◆ Applications of factor groups to automorphism groups

Unit-III Direct Products of Groups and Fundamental Theorem of Finite Abelian Groups

- ◆ External direct products of groups and its properties
- ◆ The group of units modulo n as an external direct product
- ◆ Applications to data security and electric circuits ◆ Internal direct products
- ◆ Fundamental theorem of finite abelian groups and its isomorphism classes

Essential Reading

1. Gallian, Joseph. A. (2017) - Contemporary Abstract Algebra (9th Edition) - Cengage Learning India Private Limited, Delhi (Indian Reprint 2021)
[View/Download \(11.42 MB\)](#)

Additional Readings

- Artin, Michael (1991) - Algebra (2nd Edition) - Pearson Education (Indian Reprint 2015)
[\[2014\] View/Download \(4.64 MB\)](#)
- Dummit, David S. & Foote, Richard M. (2016) - Abstract Algebra (3rd Edition) - (Student Edition) Wiley India
[\[2004\] View/Download \(34.96 MB\)](#)
- Herstein, I. N. (1975) - Topics in Algebra (2nd Edition) - Wiley India (Reprint 2022)
[View/Download \(10.4 MB\)](#)
- Rotman, Joseph J. (1995) - An Introduction to The Theory of Groups (4th Edition) - Springer Verlag, New York
[View/Download \(38.69 MB\)](#)

DSC-VIII RIEMANN INTEGRATION

Unit-I The Riemann Integral

- ◆ Definition of upper and lower Darboux sums ◆ Darboux integral
- ◆ Inequalities for upper and lower Darboux sums
- ◆ Necessary and sufficient conditions for the Darboux integrability
- ◆ Riemann's definition of integrability by Riemann sum and the equivalence of Riemann's and Darboux's definitions of integrability ◆ Definition and examples of the Riemann-Stieltjes integral

Unit-II Properties of The Riemann Integral and Fundamental Theorems

- ◆ Riemann integrability of monotone functions and continuous functions
- ◆ Properties of Riemann integrable functions
- ◆ Definitions of piecewise continuous and piecewise monotone functions and their Riemann integrability
- ◆ Intermediate value theorem for integrals ◆ Fundamental Theorems of Calculus (I and II)

Unit-III Applications of Integrals and Improper Integrals

- ◆ Methods of integration: integration by substitution and integration by parts
- ◆ Volume by slicing and cylindrical shells
- ◆ Length of a curve in the plane and the area of surfaces of revolution
- ◆ Improper integrals of Type-I, Type-II and mixed type ◆ Convergence of improper integrals
- ◆ The beta and gamma functions and their properties

Essential Readings

1. Ross, Kenneth A. (2013) - Elementary Analysis: The Theory of Calculus (2nd Edition) - Undergraduate Texts in Mathematics, Springer
[View/Download \(3.28 MB\)](#)
2. Anton, Howard, Bivens, Irl & Davis, Stephens (2012) - Calculus (10th Edition) - John Wiley & Sons, Inc.
[View/Download \(22.83 MB\)](#)
3. Denlinger, Charles G. (2011) - Elements of Real Analysis - Jones & Bartlett India Pvt. Ltd. (Indian Reprint)
[View/Download \(180.95 MB\)](#)
4. Ghorpade, Sudhir R. & Limaye, B. V. (2006) - A Course in Calculus and Real Analysis - Undergraduate Texts in Mathematics, Springer (SIE) (Indian Reprint)
[View/Download \(4.46 MB\)](#)

Additional Readings

- Bartle, Robert G. & Sherbert, Donald R. (2015) - Introduction to Real Analysis (4th Edition) - Wiley (Indian Edition)
[2011] [View/Download \(9.18 MB\)](#)
- Kumar, Ajit & Kumaresan, S. (2014) - A Basic Course in Real Analysis - CRC Press, Taylor & Francis Group (Special Indian Edition)
[View/Download \(3.59 MB\)](#)

DSC-IX DISCRETE MATHEMATICS

Unit-I Cardinality and Partially Ordered Sets

- ◆ The cardinality of a set ◆ Definitions, examples and basic properties of posets
- ◆ Order-isomorphisms ◆ Covering relations ◆ Hasse diagrams
- ◆ Dual of an ordered set ◆ Duality principle ◆ Bottom and top elements
- ◆ Maximal and minimal elements ◆ Zorn's lemma ◆ Building new ordered sets
- ◆ Maps between ordered sets

Unit-II Lattices

- ◆ Lattices as ordered sets ◆ Lattices as algebraic structures ◆ Sublattices
- ◆ Products ◆ Lattice isomorphism
- ◆ Definitions, examples and properties of modular and distributive lattices
- ◆ The $M_3 - N_5$ theorem with applications ◆ Complemented lattice
- ◆ Relatively complemented lattice ◆ Sectionally complemented lattice

Unit-III Boolean Algebras and Applications

- ◆ Boolean algebras ◆ DeMorgan's laws ◆ Boolean homomorphism
- ◆ Representation theorem ◆ Boolean polynomials ◆ Boolean polynomial functions
- ◆ Equivalence of Boolean polynomials
- ◆ Disjunctive normal form and conjunctive normal form of Boolean polynomials
- ◆ Minimal forms of Boolean polynomials ◆ Quine–McCluskey method
- ◆ Karnaugh diagrams ◆ Switching circuits and applications
- ◆ Applications of Boolean algebras to logic, set theory and probability theory

Practical

Practical/Lab work to be performed in a computer Lab using any of the Computer Algebra System Software such as Mathematica/MATLAB/Maple/Maxima/Scilab/SageMath etc., for the following problems based on:

- 1) Expressing relations as ordered pairs and creating relations.
- 2) Finding whether or not, a given relation is:
 - i. Reflexive
 - ii. Anti-symmetric
 - iii. Transitive
 - iv. Partial order
- 3) Finding the following for a given partially ordered set
 - i. Covering relations.
 - ii. The corresponding Hasse diagram representation.

- iii. Minimal and maximal elements.
- 4) Finding the following for a subset S of a given partially ordered set P
 - i. Whether a given element in P is an upper bound (lower bound) of S or not.
 - ii. Set of all upper bounds (lower bounds) of S .
 - iii. The least upper bound (greatest lower bound) of S , if it exists.
- 5) Creating lattices and determining whether or not, a given partially ordered set is a lattice.
- 6) Finding the following for a given Boolean polynomial function:
 - i. Representation of Boolean polynomial function and finding its value when the Boolean variables in it take particular values over the Boolean algebra $\{0, 1\}$.
 - ii. Display in table form of all possible values of Boolean polynomial function over the Boolean algebra $\{0, 1\}$.
- 7) Finding the following:
 - i. Dual of a given Boolean polynomial/expression.
 - ii. Whether or not two given Boolean polynomials are equivalent.
 - iii. Disjunctive normal form (Conjunctive normal form) from a given Boolean expression.
 - iv. Disjunctive normal form (Conjunctive normal form) when the given Boolean polynomial function is expressed by a table of values.
- 8) Representing a given circuit diagram (expressed using gates) in the form of Boolean expression.
- 9) Minimizing a given Boolean expression to find minimal expressions.

Essential Readings

1. Davey, B. A. & Priestley, H. A. (2002) - Introduction to Lattices and Order (2nd Edition) - Cambridge University Press, Cambridge
[View/Download \(1.66 MB\)](#)
2. Goodaire, Edgar G. & Parmenter, Michael M. (2006) - Discrete Mathematics with Graph Theory (3rd Edition) - Pearson Education Pvt. Ltd. (Indian Reprint)
[View/Download \(12.9 MB\)](#)
3. Lidl, Rudolf & Pilz, Gunter (2004) - Applied Abstract Algebra (2nd Edition) - Undergraduate Texts in Mathematics, Springer (SIE) (Indian Reprint)
[\[1998\] View/Download \(7.55 MB\)](#)

Additional Readings

- Donnellan, Thomas (1999) - Lattice Theory (1st Edition) - Khosla Pub. House (Indian Reprint)
[\[1998, Elsevier\] View/Download \(9.81 MB\)](#)
- Rosen, Kenneth H. (2019) - Discrete Mathematics and its Applications (8th Edition), Indian adaptation by Kamala Krithivasan - McGraw-Hill Education (Indian Reprint 2021)
[View/Download \(8.32 MB\)](#)

DSE-I(i) GRAPH THEORY

Unit-I Graphs, Paths and Circuits

- ◆ Definition, Examples and basic properties of graphs ◆ Subgraphs ◆ Pseudographs
- ◆ Complete graphs ◆ Bipartite graphs ◆ Isomorphism of graphs ◆ Paths and circuits
- ◆ Connected graphs ◆ Eulerian circuits ◆ Hamiltonian cycles ◆ Adjacency matrix
- ◆ Weighted graph ◆ Travelling salesman problem ◆ Shortest path ◆ Dijkstra's algorithm

Unit-II Applications of Paths and Circuits, Trees

- ◆ Applications of Path and Circuits: The Chinese Postman Problem, Digraphs, Bellman–Ford Algorithm, Tournaments, Scheduling Problem ◆ Trees ◆ Properties of Trees ◆ Spanning Trees
- ◆ Minimum Spanning Tree Algorithms

Unit-III Connectivity and Graph Coloring, Planar Graphs

- ◆ Cut-vertices ◆ Blocks and their Characterization ◆ Connectivity and edge-connectivity
- ◆ Planar graphs ◆ Euler's formula ◆ Kuratowski theorem ◆ Graph coloring and applications
- ◆ Matchings ◆ Hall's theorem ◆ Independent sets and covers

Essential Readings

1. Goodaire, Edgar G. & Parmenter, Michael M. (2006) - Discrete Mathematics with Graph Theory (3rd Edition) - Pearson Education Pvt. Ltd. (Indian Reprint)
[View/Download \(12.9 MB\)](#)
2. Chartrand, Gary & Zhang, Ping (2012) - A First Course in Graph Theory - Dover Publications
[View/Download \(6.71 MB\)](#)

Additional Readings

- Bondy, J. A. & Murty, U.S.R. (2008) - Graph Theory - Graduate Texts in Mathematics, Springer
[View/Download \(5.21 MB\)](#)
- Diestel, Reinhard (2017) - Graph Theory (5th Edition) - Graduate Texts in Mathematics, Springer
[View/Download \(2.81 MB\)](#)
- West, Douglas B. (2001) - Introduction to Graph Theory (2nd Edition) - Prentice Hall (Indian Reprint) [2002] [View/Download \(62.65 MB\)](#)

DSE-I(ii) MATHEMATICAL PYTHON

Unit-I Drawing Shapes, Graphing and Visualization

- ◆ Drawing diverse shapes using code and Turtle ◆ Using matplotlib and NumPy for data organization, structuring and plotting lines, bars, markers, contours and fields, managing subplots and axes
- ◆ Pyplot and subplots ◆ Animations of decay, Bayes update, Random walk

Unit-II Numerical and Symbolic Solutions of Mathematical Problems

- ◆ NumPy for scalars and linear algebra on n -dimensional arrays: Computing eigenspace, Solving dynamical systems on coupled ordinary differential equations ◆ Functional programming fundamentals using NumPy ◆ Symbolic computation and SymPy: Differentiation and integration of functions, Limits, Solution of ordinary differential equations, Computation of eigenvalues, Solution of expressions at multiple points (lambdify) ◆ Simplification of expressions ◆ Factorization
- ◆ Collecting and canceling terms ◆ Partial fraction decomposition ◆ Trigonometric simplification
- ◆ Exponential and logarithms ◆ Series expansion and finite differences ◆ Solvers
- ◆ Recursive equations

Unit-III Document Generation with Python and L^AT_EX

◆ Pretty printing using SymPy ◆ pandas API for IO tools: interfacing Python with text/csv, HTML, L^AT_EX, XML, MS Excel, OpenDocument, and other such formats ◆ PyLaTeX and writing document files from Python with auto-computed values ◆ Plots and visualizations

Practical

Software labs using IDE such as Spyder and Python Libraries.

- Installation, update, and maintenance of code, troubleshooting.
- Implementation of all methods learned in theory.
- Explore and explain API level integration and working of two problems with standard Python code.

Essential Readings

1. Farrell, Peter (2019) - Math Adventures with Python - No Starch Press
[View/Download \(17.46 MB\)](#)
2. Farrell, Peter and et al. (2020) - The Statistics and Calculus with Python Workshop - Packet Publishing Ltd.
[View/Download \(15.48 MB\)](#)
3. Saha, Amit (2015) - Doing Math with Python - No Starch Press
[View/Download \(6.54 MB\)](#)

Additional Reading

- Morley, Sam (2022) - Applying Math with Python (2nd Edition) - Packet Publishing Ltd.
[View/Download \(17.73 MB\)](#)
- Online resources and documentation on the libraries, such as:
 - <https://matplotlib.org>
 - <https://sympy.org>
 - <https://pandas.pydata.org>
 - <https://numpy.org>
 - <https://pypi.org>
 - <https://patrickwalls.github.io/mathematicalpython/>

DSE-I(iii) NUMBER THEORY

Unit-I Linear Diophantine equation and Theory of Congruences

◆ The Euclidean Algorithm and linear Diophantine equation ◆ Least non-negative residues and complete set of residues modulo n ◆ Linear congruences, The Chinese remainder theorem and system of linear congruences in two variables ◆ Fermat's little theorem ◆ Wilson's theorem and its converse ◆ Application to solve quadratic congruence equation modulo odd prime p

Unit-II Number-Theoretic Functions and Primitive Roots

◆ Number-theoretic functions for the sum and number of divisors ◆ Multiplicative function ◆ Möbius inversion formula and its properties ◆ Greatest integer function with an application to the calendar ◆ Euler's Phi-function ◆ Euler's theorem and some properties of the Phi-function ◆ The order of an integer modulo n and primitive roots for primes ◆ Primitive roots of composite numbers n : when n is of the form 2^k , and when n is a product of two coprime numbers

Unit-III Quadratic Reciprocity Law and Public Key Cryptosystems

- ◆ The quadratic residue and nonresidue of an odd prime and Euler's criterion
- ◆ The Legendre symbol and its properties ◆ Quadratic Reciprocity law and its application
- ◆ Introduction to Cryptography, Hill's cipher, Public-key Cryptography and RSA

Essential Reading

1. Burton, David M. (2011) - Elementary Number Theory (7th Edition) - McGraw-Hill Education Pvt. Ltd. (Indian Reprint 2017)
[View/Download \(6.38 MB\)](#)

Additional Readings

- Andrews, George E. (1994) - Number Theory - Dover Publications Inc., New York
[1971, Saunders] [View/Download \(11.95 MB\)](#)
- Robbins, Neville (2007) - Beginning Number Theory (2nd Edition) - Narosa Publishing House Pvt. Ltd.
[Not Available](#)
- Rosen, Kenneth H. (2011) - Elementary Number Theory and its Applications (6th Edition) - Pearson Education (Indian Reprint 2015)
[View/Download \(36.41 MB\)](#)