



GOVT.NAGARJUNAPG COLLEGE OF SCIENCE,
RAIPUR (CG)

Part A : Introduction

Part A : Introduction				
Program: Bachelor in Science (Honors / Honors with Research)		Semester-VII		Session:2026-27
		Subject-Mathematics (JULY 2026 TO DEC.2026)		
1	Course Code	MASC-07		
2	Course Title	Advanced Real Analysis (I)		
3	Course Type	Discipline Specific Course (DSC)		
4	Pre-requisite (if any)	Knowledge of basic real analysis, sequence, series		
5	Course Learning Outcomes(CLO)	At the end of the course, the students will be able to: 1. Understand the concept of sequence and series of functions, power series apply the test for their convergence, divergence and apply Abel's and Tauber's theorems. 2. Understand the concept of functions of several variables and properties of sets of vectors in R^n, maxima and minima of real valued functions from R to R and from R^n to R, concepts of integration theory that is closely related to the theory of Euclidean spaces and derivatives of functions of several variables. 3. Understand the concepts of Riemann-Stieltjes integral and apply it to evaluate definite integrals arising in different fields of science and engineering.		
6	Credit Value	5 C		1 Credit =15 hours – Learning and Observation
7	TotalMarks-75	ESE:60	CIA: 15	Min. Passing Marks: 30

Part B : Content of the Course

Total Period: 75

Unit	Topics	No. of Lectures
I	Sequences and series of functions, pointwise and uniform convergence, Cauchy criterion for uniform convergence, Weierstrass M-test, Abel's and Dirichlet's tests for uniform convergence, uniform convergence and continuity, uniform convergence and differentiation, Weierstrass approximation theorem.	15
II	Power series, uniqueness theorem for power series, Abel's and Tauber's theorems. Rearrangements of terms of a series, Riemann's theorem.	15

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III	Functions of several variables, linear transformations, Derivatives in an open subset of R^n , Chain rule, Partial derivatives, interchange of the order of differentiation, Derivatives of higher orders, Taylor's theorem, Inverse Function theorem, Implicit function theorem.	15
IV	Jacobians, extremum problems with constraints, Lagrange's Multiplier method, Differentiation of integrals.	15
V	Partitions of unity, Differential forms, Stoke's theorem.	15

Part C : Learning Resources

Text Books Reference Books, Other Resources

Books Recommended:

1. Walter Rudin, Principle of Mathematical Analysis, (3rd Edition) McGraw-Hill, Kogakusha, 1976.
2. H. L. Roydon, Real Analysis, Macmillan Pub. Co. Inc. (4th Edition), New York, 1962.

Reference Books :

1. T.M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.
2. G. Klambauer, Mathematical Analysis, Marcel Dekkar, Inc. New York, 1975.
3. A. J. White, Real Analysis : an introduction, Addison-Wesley Publishing Co., Inc., 1968.
4. G. de Barra, Measure Theory and Integration, Wiley Eastern Limited, 1981.
5. E. Hewitt and K. Stromberg, Real and Abstract Analysis, Berlin, Springer, 1969.
6. P.K. Jain and V. P. Gupta, Lebesgue Measure and Integration, New Age International Pvt. Ltd., New Delhi, 1986.
7. I. P. Natanson, Theory of Functions of a Real Variable. Vol. 1, Frederick Ungar Publishing Co., 1961.
8. R. L. Wheeden and A. Zygmund, Measure and Integral: An Introduction to Real Analysis, Marcel Dekker Inc. 1977.
9. J. H. Williamson, Lebesgue Integration, Holt Rinehart and Winston, Inc. New York, 1962.
10. A. Friedman, Foundations of Modern Analysis, Holt, Rinehart and Winston, Inc., New York, 1970.
11. P. R. Halmos, Measure Theory, Van Nostrand, Princeton, 1950.
12. T. G. Hawkins, Lebesgue's Theory, of Integration: Its Origins and Development, Chelsea, New York, 1979.
13. K. R. Parthasarathy, Introduction to Probability and Measure, Macmillan Company of India Ltd., Delhi, 1977.
14. R. G. Bartle, The Elements of Integration, John Wiley & Sons, Inc. New York, 1966.
15. Serge Lang, Analysis I & II, Addison- Wesley Publishing Company, Inc. 1969.
16. Inder K. Rana, An Introduction to Measure and Integration, Norosa Publishing House, Delhi, 1997.
17. Walter Rudin, Real & Complex Analysis, Tata McGraw-Hill Publishing Co. Ltd. New Delhi, 1966.

Suggested Digital Platforms / Web links:

1. <https://nlist.inflibnet.ac.in/>
2. <http://libgen.rs/>
3. <https://open.unn.edu/opentextbooks/subjects/mathematics>
4. <https://epgp.inflibnet.ac.in/>
5. <https://onlinecourses.nptel.ac.in>
6. <https://swayam.gov.in>
7. <https://www.mooc.org>



GOVT. NAGARJUNAPGA COLLEGE OF SCIENCE,
RAIPUR (CG)

Part A : Introduction

Part A : Introduction				
Program: Bachelor in Science (Honors/ Honors with Research)		Semester-VII		Session:2026-27
		Subject-Mathematics (JULY 2026 TO DEC.2026)		
1	Course Code	MASE-06		
2	Course Title	Topology		
3	Course Type	Discipline Specific Elective (DSE-I)		
4	Pre-requisite (if any)	Knowledge of basic ideas of set theory and analysis including Metric spaces		
5	Course Learning Outcomes(CLO)	At the end of the course, the students will be able to: 1. Understand the concept of countable and uncountable sets and its properties. Understand the concept of topological spaces and its examples, bases, sub-bases, subspaces and relative topology. 2. Understand the concept of countable, separable spaces and separation axioms with their characterizations and basic properties. 3. Understand the concepts and properties of compactness, continuous functions, countable compactness in metric spaces, connectedness, continuous functions.		
6	Credit Value	5 C		1 Credit =15 hours – Learning and Observation
7	TotalMarks-75	ESE:60	CIA: 15	Min. Passing Marks: 30

Part B: Content of the Course

Total Period : 75

Unit	Topics	No. of Lectures
I	Countable and uncountable sets. Infinite sets and the Axiom of Choice. Cardinal numbers and its arithmetic. Schroeder-Bernstein theorem. Cantor's theorem and the continuum hypothesis. Zorn's lemma, well-ordering theorem.	15

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II	Definition and examples of topological spaces. Bases and sub-bases. Subspaces and relative topology. Alternate methods of defining a topology in terms of terms of Kuratowski Closure Operator and Neighbourhood Systems. Continuous functions and homeomorphism.	15
III	First and Second Countable spaces. Lindelof's theorems. Separable spaces. Second countability and separability. Separation axioms; their Characterizations and basic properties. Urysohn's lemma, Tietze Extension theorem.	15
IV	Compactness. Continuous functions and compact sets. Basic properties of Compactness. Compactness and finite intersection property. Sequentially and countably compact sets. Local compactness and one-point compactification. Stone-Cech compactification.	15
V	Compactness in metric spaces. Equivalence of compactness, countable compactness and sequential compactness in metric space. Connected spaces. Connectedness on the real line. Components. Locally connected spaces	15

Part C: Learning Resources

Text Books, Reference Books, Other Resources

Recommended books:

8. James R. Munkres, *Topology*, (2nd Edition) Pearson Education, New Delhi, 2021.
9. K. D. Joshi, *Introduction to General Topology*, (3rd Edition), New Age International Pvt. Ltd., India, 2022.

References:

10. J. Dugundji, *Topology*, Allynand Bacon, Prentice Hall of India Pvt. Ltd., India, 1966.
11. G. F. Simmons, *Introduction to Topology and Modern Analysis*, McGraw Hill Education, 2017.
12. J. Hocking, G. Young *Topology*, New Edition, Dover Publications Inc, 1988.
13. J. L. Kelley, *General Topology*, Reprint Edition, Dover Publications Inc., 2017.

Suggested Digital Platforms / Web links:

14. <https://nlist.inflibnet.ac.in/>
15. <http://libgen.rs/>
16. <https://open.umn.edu/opentextbooks/subjects/mathematics>
17. <https://epgp.inflibnet.ac.in/>
18. <https://onlinecourses.nptel.ac.in>
19. <https://swayam.gov.in>
20. <https://www.mooc.org>



GOVT.NAGARJUNAPGCOLLEGE OF SCIENCE,
RAIPUR (CG)

Part A : Introduction

Part A : Introduction				
Program: Bachelor in Science (Honors / Honors with Research)		Semester-VII		Session : 2026-27
		Subject-Mathematics (JULY 2026 TO DEC.2026)		
1	Course Code	MASE-07		
2	Course Title	Complex Analysis-I		
3	Course Type	Discipline Specific Elective(DSE-II)		
4	Pre-requisite (if any)	Basic knowledge of complex analysis and calculus.		
5	Course Learning Outcomes(CLO)	At the end of the course, the students will be able to: 1. Explain the fundamental concepts of complex analysis and their role in modern mathematics and applied contexts. 2. Demonstrate accurate and efficient use of complex analysis techniques. 3. Demonstrate capacity for mathematical reasoning through analysing, proving and explaining concepts from complex analysis 4. Apply problem-solving using complex analysis techniques applied to diverse situations in physics, engineering and other mathematical contexts. 5. Understand complex integration ,Cauchy– Goursat Theorem ,Cauchy’s integral formula. 6. Understand Laurent’s series, Isolated singularities, Meromorphic functions and Rouche’s theorem. 7. Explain Mobius transformations, Fixed points, Cross ratio, Bilinear transformations and Conformal mappings. 8. Understand the Residues, Cauchy’s residue theorem, Evaluation of integrals and branches of many valued functions.		
6	Credit Value	5 C		1 Credit =15 hours – Learning and Observation
7	Total Marks-75	ESE:60	CIA: 15	Min. Passing Marks: 30

Part B:Content of the Course

Total Period:75

Unit	Topics	No. of Lectures
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Session 2026-27

I	Complex integration, Cauchy-Goursat. Theorem. Cauchy's integral formula. Higher order derivatives. Morera's Theorem. Cauchy's inequality and Liouville's theorem. The fundamental theorem of algebra. Taylor's theorem. Laurent's series. Isolated singularities. Meromorphic functions.	15
II	Maximum modulus principle. Schwarz lemma. The argument principle. Rouché's theorem, Inverse function theorem.	15
III	Residues. Cauchy's residue theorem. Evaluation of integrals. Branches of many valued functions with special reference to $\text{Arg } z$, $\log z$ and z^a .	15
IV	Bilinear transformations, their properties and classifications. Definitions and examples of Conformal mappings.	15
V	Spaces of analytic functions. Hurwitz's theorem. Montel's theorem. Riemann mapping theorem.	15

Part C: Learning Resources

Text Books, Reference Books, Other Resources

Books Recommended:

1. L. V. Ahlfors, *Complex Analysis*, McGraw-Hill, 1979.
2. J.B. Conway, *Functions of one Complex variable*, Narosa Publishing House, 1980.

Reference Books:

1. H.A. Priestly, *Introduction to Complex Analysis*, Clarendon Press, Oxford, 1990.
2. D. Sarason, *Complex Function Theory*, (2nd Edition) American Mathematical Society, 2007.
3. Liang-shin Hahn & Bernard Epstein, *Classical Complex Analysis*, Jones and Bartlett Publishers International, London, 1996.
4. S. Lang, *Complex Analysis*, Addison Wesley, 1977.
5. Mark J. Ablowitz and A.S. Fokas, *Complex Variables: Introduction and Applications*, Cambridge University press, South Asian Edition, 1998.
6. E. Hille, *Analytic Function Theory* (2 Vols.) Gonn & Co., 1959.
7. W.H.J. Fuchs, *Topics in the Theory of Functions of one Complex Variable*, D. Van Nostrand Co., 1967.
8. C. Caratheodory, *Theory of Functions* (2 Vols.) Chelsea Publishing Company, 1964.
9. M. Heins, *Complex Function Theory*, Academic Press, 1968.
10. Walter Rudin, *Real and Complex Analysis*, McGraw-Hill Book Co., 1966.
11. S. Saks and A. Zygmund, *Analytic Functions*, Monografic Matematyczne, 1952.
12. E. C. Titchmarsh, *The Theory of Functions*, Oxford University Press, London, 1939.
13. W.A. Veech, *A Second Course in Complex Analysis*, W.A. Benjamin, 1967.
14. S. Ponnusamy, *Foundations of Complex Analysis*, Narosa Publishing House, 1997.

Suggested Digital Platforms / Web links:

1. <https://nlist.inflibnet.ac.in/>
2. <http://libgen.rs/>
3. <https://open.umn.edu/opentextbooks/subjects/mathematics>
4. <https://epgp.inflibnet.ac.in/>



GOVT.NAGARJUNAPGCOLLEGE OF SCIENCE,
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Part A: Introduction

Program: Bachelor in Science
(Honors/ Honors with Research)

Semester-VII

Session:2026-27

Subject-Mathematics (JULY 2026 TO DEC.2026)

1 Course Code

MASE-08

2 Course Title

Discrete Mathematics

3 Course Type

Discipline Specific Elective (DSE-III)

4 Pre-requisite (if any)

Basic idea of logic and order relations

5

Course Learning
Outcomes(CLO)

At the end of the course, the students will be able to:

1. Describe formal logic, including symbolic representation, tautologies. Apply quantifiers, predicates, and propositional logic. Evaluate the validity of logical arguments. Explain concepts of semigroups and monoids, including concatenation operations.
2. Analyse homomorphisms on semigroups and monoids, apply congruence relations, construct quotient semigroups. Describe direct products in semigroups and monoids.
3. Express lattices as partially ordered sets and its properties. Apply concepts of sublattices, direct products, and homomorphisms. Explain complete, complemented, and distributive lattices. Apply Boolean algebra properties in various contexts.
4. Express Boolean Forms as direct products, homomorphisms, minterms, maxterms and their equivalence. Apply Boolean algebra principles to switching theory and Karnaugh map method for minimization.
5. Analyse phrase-structure grammars, rewriting rules, derivations, and sentential forms. Examine languages generated by grammars. Distinguish regular, context-free, and context-sensitive grammars and languages. Convert infix expressions to Polish notations and Reverse Polish notations.

6

Credit Value

5 C

1 Credit = 15 hours – Learning and
Observation

7

Total Marks-75

ESE:60

CIA: 15

Min. Passing Marks: 30

Session 2026-27

PartB: Content of the Course**TotalPeriod:75**

Unit	Topics	No. of Lectures
I	Formal Logic-Statements. Symbolic Representation and Tautologies. Quantifiers, Predicates and Validity. Propositional Logic. Semigroups & Monoids-Definitions and Examples of Semigroups and monoids (including those pertaining to concatenation operation).	15
II	Homomorphism of semigroups and monoids. Congruence relation and Quotient Semigroups. Sub-semigroup and sub-monoids. Direct Products. Basic Homomorphism Theorem.	15
III	Lattices-Lattices as partially ordered sets. Their properties. Lattices as Algebraic Systems. Sublattices, Direct products, and Homomorphisms. Some Special Lattices e.g., Complete, Complemented and Distributive Lattices. Boolean Algebras-Boolean Algebras as Lattices. Various Boolean Identities. The Switching Algebra example. Subalgebras.	15
IV	Direct Products and Homomorphisms. Join-Irreducible elements, Atoms and Minterms. Boolean Forms and Their Equivalence. Minterm Boolean Forms, Sum of Products Canonical Forms. Minimization of Boolean Functions. Applications of Boolean Algebra to Switching Theory (using AND, OR & NOT gates). The Karnaugh Map Method.	15
V	Grammars and Languages-Phrase-Structure Grammars. Rewriting Rules. Derivations. Sentential Forms. Language generated by a Grammar. Regular, Context-Free, and Context Sensitive Grammars and Languages. Regular sets, Regular Expressions. Notions of Syntax Analysis, Polish Notations. Conversion of Infix Expressions to Polish Notations. The Reverse Polish Notation.	15

Part C: Learning Resources

Text Books. Reference Books, Other Resources

Books Recommended:

1. C. I. Liu, Elements of Discrete Mathematics, McGraw Hill Education India, 1986
2. J.P. Tremblay & R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co., 1997.

Reference Books:

1. J.L. Gersting, Mathematical Structures for Computer Science, W.H. Freeman and Company, 2003.
2. Seymour Lipschutz, Finite Mathematics, McGraw-Hill Book Company, 1983.
3. S. Wiitala, Discrete Mathematics- A Unified Approach, McGraw- Hill Book Co., 1987
4. J.E. Hopcroft and J.D Ullman, Introduction to Automata Theory, Languages & Computation, Narosa Publishing House, 2001
5. N. Deo, Graph Theory with Application to Engineering and Computer Sciences, Prentice Hall of India, 1979
6. K.L.P. Mishra and N. Chandrashekar, Theory of Computer Science, Prentice Hall of India, 200



GOVT.NAGARJUNAPG COLLEGE OF SCIENCE,
RAIPUR (CG)

Part A : Introduction

Program: Bachelor in Science (Honors / Honors with Research)		Semester-VII	Session: 2026-27
		Subject-Mathematics (JULY 2026 TO DEC. 2026)	
1	Course Code	MATRM-07	
2	Course Title	Research Methodology	
3	Course Type	Research Oriented	
4	Pre-requisite (if any)	Basic knowledge of computer, Use of internet, Knowledge of Under graduate courses of Mathematics	
5	Course Learning Outcomes(CLO)	At the end of the course, the students will be able to: 1 Understand fundamental knowledge of research methods and design used in research, selected research problem. 2. Understand importance of scientific writing, importance of word selection, journals and their abbreviations. 3. Understand mathematics subject classification and mathematical review and mathscinet, structure of mathematical research paper. 4. Use Latex for mathematical typesetting, making bibliography and slides. 5. Use MATLAB for scientific computing, plotting curves and surfaces,	
6	Credit Value	5 C	1 Credit = 15 hours – Learning and Observation
7	Total Marks-75	ESE: 60	CIA: 15
		Min. Passing Marks: 30	

Part B : Content of the Course

Total Period: 60

Unit	Topics	No. of Lectures
I	Research Methodology: Introduction to research methodology, Meaning, objectives, types, significance of Research. Identification, Selection of Research problem, Formulation of research objectives, Research design, components, importance and typology Quantitative and qualitative methodology, hypotheses. Research ethics.	12

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II	Typesetting Mathematical Text with LATEX: Sample Document, Type Style, Environments, Lists, Centering, Tables, Verbatim, Vertical and Horizontal Spacing. Equation Environments, Fonts, Hats, and Underlining, Braces, Arrays and Matrices, Customized Commands, Theorem-like Environments, Math Styles, Document Classes and the Overall Structure, Titles for Documents, Sectioning Commands, Packages, Inputting Files, Inputting Pictures, making a Bibliography, Making an Index, Slides.	12
III	MATLAB: Arithmetic Operations, built-in-MATH functions, scalar variables, Creating Arrays, built-in-functions for handling arrays, Mathematical Operations with Arrays, Script Files, Two dimensional plots, programming in MATLAB, Polynomial, curve fitting, and interpolation, Three-dimensional plots.	12
IV	Internet Resources Library Classification Schemes, Review, Abstract and Citation Services, Mathematics Subject Classifications (MSC). Mathematical Review, MathSciNet and other E-Resources, Text Editors, Spelling Checking, Filters and Pipes, Style Checkers.	12
V	Process of Research Selection of a research topic and a research problem, Literature survey of the topic and a problem, Role of a supervisor, Studying, reviewing and publishing a paper,	12

Keywords/Tags –Research design, LATEX, MATLAB Mathematics Subject Classifications, MathSciNet, publishing paper.

Part C: Learning Resources

Text Books. Reference Books, Other Resources

Books recommended:

1. C.R. Kothari ,Research Methodology, New Age International Publishers (2004)
2. Michael Davis: Ethics and the University. Routledge (1999)
3. Donald Bindner and Martin Erickson: A student's guide to the study, practice ,and tools of modern mathematics, CRC Press, (2011)
4. Nicholas J. Higham: Hand book of writing for the Mathematical Sciences, Society for Industrial and Applied Mathematics; 2nd edition (1998)
5. Harold Rabinowitz, Suzanne Vogel: The Manual of Scientific Style. Academic Press (2009)
6. Laslie Lamport : LATEX. Addison Wesley Publication Company (1994)
7. David F. Griffiths, Desmond J. Higham: Learning LATEX. Society for Industrial and Applied Mathematics, Philadelphia (1997)

Session 2026-27

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**GOVT.NAGARJUNAPG COLLEGE OF SCIENCE,
RAIPUR (CG)**

Part A: Introduction

Program: Bachelor in Science (Honors/Honors with Research)		Semester-VIII		Session:2026-27	
		Subject-Mathematics (JAN.2027 TO JUNE 2027)			
1	Course Code	MASC-08			
2	Course Title	Advanced Abstract Algebra(I)			
3	Course Type	Discipline Specific Course(DSC)			
4	Pre-requisite (If any)	Knowledge of Abstract Algebra			
5	Course Learning Outcomes(CLO)	At the end of the course, the students will be able to: 1. Illustrate cyclic, simple, semi-simple, and free modules. State and prove properties and theorems of Noetherian and Artinian modules and rings, including the Hilbert Basis Theorem and the Wedderburn-Artin Theorem. Discuss significance of uniform and primary modules. 2. Describe algebraic properties of linear transformations, calculate characteristic roots. Relate matrices and linear transformations. Solve problems involving Linear transformations and matrices. 3. Explain similarity of linear transformations, invariant subspaces. Perform reduction to triangular forms. Illustrate properties of nilpotent transformations. Apply the primary decomposition theorem. 4. Apply the principles of Smith normal form over a PID and the rank of matrices and modules. Utilize the fundamental structure theorem for finitely generated modules over a PID, to deduce structure or finitely generated abelian groups. Analyze and decompose matrices and modules. 5. Evaluate and apply rational canonical form and generalized Jordan form over any field. Analyze linear transformations, matrices, and modules to determine their canonical forms. Fields of science And engineering.			
6	Credit Value	5 C		1Credit =15 hours – Learning and Observation	
7	TotalMarks-75	ESE:60	CIA: 15	Min. Passing Marks: 30	

Session 2026-27

Part B: Content of the Course

Total Period: 75

Unit	Topics	No. of Lectures
I	Modules-Cyclic modules. Simple modules. Semi-simple modules. Schuler's Lemma. Free modules. Noetherian and artinian modules and rings-Hilbert basis theorem. Wedderburn Artin theorem. Uniform modules, primary modules, and Noether-Lasker theorem.	15
II	Linear Transformations—Algebra of linear transformation, characteristic roots, matrices and linear transformations.	15
III	Canonical Forms - Similarity of linear transformations. Invariant subspaces. Reduction to triangular forms. Nilpotent transformations. Index of nilpotency. Invariants of a nilpotent transformation. The primary decomposition theorem. Jordan Blocks and Jordan forms.	15
IV	Smith normal form over a principal ideal domain and rank. Fundamental structure theorem for finitely generated modules over a Principal ideal domain and its applications to finitely Generated abelian groups.	15
V	Rational canonical form. Generalized Jordan form over any field.	15

Keywords /Tags - Modules, Linear Transformations, triangular forms. Nilpotent transformations, Smith Normal form, Jordan form, Rational canonical form. Generalised Jordan form

Part C: Learning Resources

Text Books. Reference Books, Other Resources

Books Recommended:

1. P.B. Bhattacharya, S.K. Jain, S.R. Nagpaul, *Basic Abstract Algebra*, Cambridge University press, 1994
2. I.N. Herstein, *Topics in Algebra*, Wiley Eastern Ltd., 1999
3. Quazi Zameeruddin, Surjeet Singh, *Modern Algebra*, Vikas Publishing House Pvt. Ltd., 1990

Reference Books:

1. M. Artin, *Algebra*, Prentice-Hall of India, 1991.
2. P.M. Cohn, *Algebra*, Vols. -I, II & III, John Wiley & Sons, 1982, 1989, 1991.
3. N. Jacobson, *Basic Algebra*, Vols. I, W.H. Freeman, 1980
4. S. Lang, *Algebra*, 3rd edition, Addison-Wesley, 1993.
5. I.S. Luther, J.B.S. Passi, *Algebra*, Vol. I-Groups, Vol. II-Rings, Narosa Publishing House (Vol. I- 1996, Vol. II-1999)
6. D.S. Malik, J.N. Mordeson, M.K. Sen, *Fundamentals of Abstract Algebra*, McGraw-Hill, International Edition, 1997.
7. Vivek Sahai and Vikas Bist, *Algebra*, Narosa Publishing House, 1999.
8. I. Stewart, *Galois theory*, Chapman and Hall, 1989.
9. J.P. Escofier, *Galois theory*, GTM Vol. 204, Springer, 2001.
- J.B. Fraleigh, *A first course in Algebra*, Narosa, 1982.

Session 2026-27

FOUR YEAR UNDER GRADUATE PROGRAM

DEPARTMENT OF MATHEMATICS

COURSE CURRICULUM

Part A: Introduction			
Program: Bachelor in Science (Honors/Honors with Research)	Semester - VIII		Session:2026-2027
1 Course Code	MASE-09		
2 Course Title	Measure Theory		
3 Course Type	Discipline Specific Elective (DSE)		
4 Pre-requisite (if any)	Knowledge of real analysis		
5 Course Learning Outcome (CLO)	This Course will enable the students to: ➤ Understand development of measure and integration theory and Borel, Lebesgue measurability, and compare integration theory of Lebesgue and Riemann with examples and counter examples. ➤ Understand the concept and properties of functions of bounded variation..		
6 Credit Value		1Credit 15 hours-Learning and Observation	
7 Total Marks -75	ESE:60	CIA:15	Minimum Passing Marks:30

Note: This paper is qualifying in nature

Part B: Content of the Course		
Total no of teaching-learning period 60 Periods (60 Hours)		
Unit	Topics	No. of Periods
I	Measurable Sets: Lebesgue outer measure, Lebesgue measure, Properties of measurable sets, Borel sets and their measurability characterization of measurable sets, Non measurable set.	15
II	Measurable Function: Definition and properties, Simple, Step and characteristics function, Continuous function, sets of measure Zero. Sequence of functions, Egoroff's theorem structure of measurable function, Lusin theorem, Frechet theorem, Convergence in measure, Riesz theorem.	15
III	Lebesgue Integral: Lebesgue integral of a bounded function,	15

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	Comparison of Riemann integral and Lebesgue integral, Bounded Convergence Theorem, Integral of non negative measurable functions, Fatou's lemma, Monotone convergence theorem, General Lebesgue integral, Lebesgue dominated convergence theorem.	
IV	Differentiation and Integration: Dini derivatives, Differentiation of monotone functions, Lebesgue theorem, Function of bounded variation, Differentiation of an integral, Lebesgue sets, Absolutely Continuous Functions, Integral of the derivatives	15

Part C-Learning Resource
Text Books, Reference Books, Other Resources
Text Books Recommended: 1. G.de Barra, Measure Theory and Integration, Wiley Eastern Limited, 1981. 2. P.K. Jain and V.P. Gupta, Lebesgue Measure and New Age International (P) Limited Published, New Delhi, 1986 Reprint 2000). 3. Inder K. Rana, An Introduction to Measure and Integration, Norosa Publishing House, Delhi, 1997
Reference Books Recommended: 1. Richard L. Wheeden and Antoni Zygmund, Measure and Integral: An Introduction to Real Analysis, Marcel Dekker Inc. 1977. 2. J.H. Williamson, Lebesgue Integration, Holt Rinehart and Winston, Inc. New York. 1962 5. P.R. Halmos, Measure Theory, Van Nostrand, Princeton, 1950. 6. T.G. Hawkins, Lebesgue's Theory, of Integration: Its Origins and Development, Chelsea, New York, 1979 7. K.R. Parthasarathy, Introduction to Probability and Measure, Macmillan Company of India Ltd., Delhi, 1977. 8. R.G. Bartle, The Elements of Integration, John Wiley & Sons, Inc. New York, 1966.
E-Recourses: https://onlinecourses.nptel.ac.in https://epqp.inflibnet.aci.in https://swayam.gov.in https://www.mooc.org

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Part D: Assessment and Evaluation		
Suggested Continuous Evaluation Methods:		
Maximum Marks: 100 Marks		
Continuous Internal Assessment (CIA): 30 Marks		
End Semester Examination (ESE) : 70 Marks		
Continuous Internal Assessment (CIA) (Conducted by course teacher)	Test/Quiz- 20+20 Marks Assignment/Seminar- 10 Marks	Better marks out of two test/quiz + obtained marks in Assignment shall be considered against 30 marks.
End Semester (ESE) Examination	Two Section-A&B Section-A: Q1.Objective- 10x1=10 marks Q2. Short answer type question- 5x4=20 marks Section-B: Descriptive answer type question, 1 out of 2 from each unit- 10x4=40 Marks	

Name and signature of convener & members of CBOS-

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GOVT. NAGARJUNAPGA COLLEGE OF SCIENCE,
RAIPUR (CG)

Part A: Introduction			
Program: Bachelor in Science (Honors / Honors with Research)		Semester-VIII	Session: 2026-27
		Subject-Mathematics (JAN.2027 TO JUNE 2027)	
1	Course Code	MASE-10	
2	Course Title	General and Algebraic Topology	
3	Course Type	Discipline Specific (DSE-I)	
4	Pre-requisite (if any)	Knowledge of topological space and related concepts	
5	Course Learning Outcomes(CLO)	At the end of the course, the students will be able to: 1. Describe projection maps. Explain Tychonoff product topology, construction terms of standard sub-bases. Relate Separation axioms and product spaces. 2. Describe connectedness and compactness in product spaces. Explain Tychonoff's theorem. Analyze countability in products spaces. 3. Describe embedding lemma, Tychonoff embedding, and Urysohn metrization theorem. Explain metrization theorems and their relationship with Paracompactness and Local finiteness, Nagata-Smirnov metrization theorem. Explain Smirnov metrization theorem. 4. Explain Nets, Filters and their convergence. relate Hausdorffness, Compactness, and Nets. Apply canonical methods to transform nets into Filters and vice versa. Explain ultra-filters in compact sets. 5. Describe Homotopy of paths, the Fundamental Group, and Covering Spaces. Explain fundamental group of the circle and its relevance to the Fundamental theorem of algebra.	
6	Credit Value	5 C	1 Credit = 15 hours – Learning and Observation
7	Total Marks-75	ESE:60	CIA: 15
		Min. Passing Marks: 30	

Session 2026-27

Part B: Content of the Course

Total Period: 75

Unit	Topics	No. of Lectures
I	Tychonoff product topology in terms of standard sub-base and its characterizations. Projection maps. Separation axioms and product spaces.	15
II	Product spaces. Connectedness and product spaces. Compactness and product spaces (Tychonoff's theorem). Countability and product spaces.	15
III	Embedding and metrization. Embedding lemma and Tychonoff embedding. The Urysohn metrization theorem. Metrization theorems and Paracompactness-Local finiteness. The Nagata-Smirnov metrization theorem. Paracompactness. The Smirnov Metrization theorem.	15
IV	Nets and filter. Topology and convergence of nets. Hausdorffness and nets. Compactness and nets. Filters and their convergence. Canonical way of converting nets to filters and vice-versa. Ultra-Filters and Compactness.	15
V	The fundamental group and coverings spaces-Homotopy of paths. The fundamental group. Covering spaces. The fundamental group of the circle and the fundamental theorem of algebra.	15

Part C: Learning Resources

Text Books, Reference Books, Other Resources

Books Recommended:

1. James R. Munkres, *Topology*, (2nd Edition) Pearson Education, New Delhi, 2021.
2. K.D. Joshi, *Introduction to General Topology* (3rd Edition), New Age International Pvt. Ltd., India, 2022.

Reference Books:

1. J. Dugundji, *Topology*, Allynand Bacon, Prentice Hall of India Pvt. Ltd., India, 1966.
2. G. F. Simmons, *Introduction to Topology and Modern Analysis*, McGraw Hill Education, 2017.
3. J. Hocking, G. Young *Topology*, New Edition, Dover Publications Inc, 1988.
4. J.L. Kelley, *General Topology*, Reprint Edition, Dover Publications Inc., 2017.
5. L. Steen, J.A. Jr. Seebach, *Counter examples in Topology*, Second Edition, Springer, 1978.
6. W. Thron, *Topologically Structures*, Holt, Rinehart and Winston, New York, 1966.
7. N. Bourbaki, *General Topology*, Springer, 1998.
8. R. Engelking, *General Topology*, Heldermann Verlag, 1989.
9. W.J. Pervin, *Foundations of General Topology*, Academic Press Inc. 2014.
10. E.H. Spanier, *Algebraic Topology*, McGraw-Hill, New York, 1966.
11. S. Willard, *General Topology*, Dover, 2004.

Suggested Digital Platforms/ Web links:

1. <https://nlist.inflibnet.ac.in/>
2. <http://libgen.rs/>
3. <https://open.umn.edu/opentextbooks/subjects/mathematics>

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GOVT.NAGARJUNAPGCOLLEGE OF SCIENCE,
RAIPUR (CG)

Part A: Introduction

Program: Bachelor in Science (Honors / Honors with Research)		Semester-VIII	Session:2026-27
		Subject-Mathematics (JAN.2027 TO JUNE 2027)	
1	Course Code	MASE-11	
2	Course Title	Complex Analysis-II	
3	Course Type	Discipline Specific Elective (DSE-II)	
4	Pre-requisite (if any)	Basic discussion of complex numbers, complex variable functions And analytic functions.	
5	Course Learning Outcomes(CLO)	At the end of the course, the students will be able to: 1. Explore meromorphic functions and Weierstrass' factorization theorem. Explain Gamma function, its properties. Analyze the Riemann Zeta function and the Riemann functional equation. Apply Runge's theorem and Mittag-Leffler's theorem. 2. Describe analytic continuation and its uniqueness. Explore power series for analytic continuation and apply Schwarz Reflection Principle. Analyze the Monodromy theorem and its consequences. 3. Explain harmonic functions. Apply Harnack's inequality and theorem to Harmonic functions. Describe Dirichlet Problem and solve boundary value problems. Explain Green's function and its applications. 4. Explain canonical products their properties. Apply Jensen's formula and the Poisson-Jensen formula to analyze the distribution of zeros of entire functions. Apply Hadamard's Three Circles Theorem to entire functions. Describe Borel's theorem and Hadamard's factorization theorem. 5. Describe the range of analytic functions, apply the theorems of Bloch, Little Picard, Schottky, Montel, Caratheodory, and the Great Picard Theorem. Explain univalent functions, their properties. State Bieberbach's Conjecture and the $1/4$- theorem.	
6	Credit Value	5 C	1 Credit =15 hours – Learning and Observation
7	Total Marks-75	ESE:60	CIA: 15
		Min. Passing Marks: 30	

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Part B: Content of the Course

Total Period: 75

Unit	Topics	No. of Lectures
I	Weierstrass' s Factorization Theorem. Gamma function and its properties. Riemann Zeta function. Riemann functional equation. Runge's theorem. Mittag- Leffler's theorem.	15
II	Analytic Continuation. Uniqueness of direct analytic continuation. Uniqueness of analytic continuation along a curve. Power series Method of analytic continuation Schwarz Reflection Principle. Monodromy theorem and its consequences.	15
III	Harmonic functions on a disk. Harnack's inequality and theorem. Dirichlet Problem. Green's function.	15
IV	Canonical products. Jensen's formula. Poisson-Jensen's formula. Hadamard's three circles theorem, order of an entire function. Exponent of convergence. Borel's theorem. Hadamard's factorization theorem.	15
V	The range of an analytic function. Bloch's theorem. The Little Picard Theorem. Schottky's theorem. Montel Carathéodory and the Great Picard Theorem Univalent functions. Bieberbach's conjecture (statement only) and the $1/4$ - theorem.	15

Part C: Learning Resources

Text Books. Reference Books, Other Resources

Books Recommended:

1. L.V. Ahlfors, *Complex Analysis*, McGraw-Hill, 1979.
2. J.B. Conway, *Functions of one Complex variable*, Narosa Publishing House, 1980.

Reference Books:

1. H.A. Priestly, *Introduction to Complex Analysis*, Clarendon Press, Oxford, 1990.
2. D. Sarason, *Complex Function Theory*, (2nd Edition) American Mathematical Society, 2007.
3. Liang-shin Hahn & Bernard Epstein, *Classical Complex Analysis*, Jones and Bartlett Publishers International, London, 1996.
4. S. Lang, *Complex Analysis*, Addison Wesley, 1977.
5. Mark J. Ablowitz and A.S. Fokas, *Complex Variables: Introduction and Applications*, Cambridge University press, South Asian Edition, 1998.

Suggested Digital Platforms / Web links:

1. <https://nlist.inflibnet.ac.in/>
2. <http://libgen.rs/>
3. <https://open.unn.edu/opentextbooks/subjects/mathematics>
4. <https://epgp.inflibnet.ac.in/>
5. <https://onlinecourses.nptel.ac.in>
6. <https://swayam.gov.in>
7. <https://www.mooc.org>

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