Part A – Introduction				
Program: 2-Year Post-Graduate Programme		**Class:** Post-Graduate I-Year (Semester – I)	**Year:** 2025	**Session:** 2025-2026
Subject: Mathematics				
1	Course Code			
2	Course Title	Advanced Abstract Algebra - I (Theory)		
3	Course Type	CC – 11		
4	Pre-requisite (if any)	To study this course, a student must have had the subject Mathematics at Degree level (3 Year Degree Course).		
5	Course Learning Outcomes (CLO)	The course will enable the students to: 1. Understand the basic concepts of group operations and their applications. 2. Apply the Sylow's theorem to characterize certain finite groups. 3. Know the fundamental concepts in ring theory such as polynomial rings. Euclidean domain and unique factorization domain. 4. Learn the fundamental properties of extension of a field. 5. Analyze and the characterize algebraic and transcendental extensions.		
6	Credit Value	5 Credits		
7	Total Marks	Max. Marks: 40 + 60	Min. Passing Marks: 40	

Part B – Content of the Course		
Total No. of Lectures (in hours per week): 5 hours per week **Total Lectures:** 75 hours		
Module	Topics	No. of Lectures
I	**Indian Knowledge System:** Contribution and biography of following Indian Mathematicians in Advanced Abstract Algebra: Dr. Harish-Chandra, Dr. V. V. Narlikar, Dr. S. S. Abhyankar	02
II	Class equation of a finite group, Centre for Group of prime power order, Cauchy's and Sylow's theorems for finite groups, Isomorphism theorems, Maximal normal groups, Simple groups. ***Suggested Activities:*** *By analyzing conjugacy classes, determine the center of the group and identify normal subgroups. Determining the structure of groups based on Sylow p-subgroups.*	18
III	Normal and Subnormal Series, Composition series of a group, Jordan-Holder theorem, Commutator subgroup of a group, Solvable groups, Nilpotent groups. ***Suggested Activities:*** *Used in the classification of finite simple groups, providing a foundation for understanding group structures. Applying the commutator subgroup to analyzing the fundamental group of topological spaces.*	15

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IV	Euclidean ring, Polynomial ring, Polynomials over a Ring, Division algorithm, Polynomial over the rational field. ***Suggested Activities:*** *Discuss how Euclidean ring and Division algorithm be used in cryptography.*	15
V	Euclidean domain, Principal ideal domain, Unique factorization domain, Quotient field. ***Suggested Activities:*** *Discuss how Euclidean domain and Unique factorization domain can be used in cryptography.*	10
VI	Extension of a fields, Roots of polynomials, Algebraic and transcendental extensions, Primitive elements, Algebraically closed field. ***Suggested Activities:*** *Discuss the applications of field extension and primitive elements in real world problems.*	15

Keywords/Tags:
Cauchy's and Sylow's theorems, Jordan-Holder theorem, Solvable groups, Nilpotent groups, Euclidean rings, Polynomial rings, Euclidean domain, Principal ideal domain, Unique factorization domain, Quotient field, Extension Field.

Part C – Learning Resources

Text Books, Reference Books, Other Resources

Suggested Readings:

Text Books:

1. P. B. Bhattacharya, S. K. Jain & S. R. Nagpaul: Basic Abstract Algebra, 2nd edition, Cambridge University Press, 2003.
2. I. N. Herstein: Topics in Algebra, Wiley Eastern Ltd. New Delhi. 1977.
3. मध्यप्रदेश हिन्दी ग्रंथ अकादमी की पुस्तकें।

Reference Books:

1. I. S. Luther and I. B. S. Passi: Algebra. Vol. I and II, Narosa Publishing House, 1997.
2. Shanti Narayan: A text Book of Modern Abstract Algebra, S. Chand and Company. New Delhi, 1967.
3. Surjeet Singh and Qazi Zameeruddin: Modern Algebra, Vikas Publishing House Pvt Ltd; Delhi, Eighth edition, 2006.

Suggested Digital Platforms Web links:
https://www.eshiksha.mp.gov.in/mpdhe
https://epgp.inflibnet.ac.in

Suggested Equivalent online courses:
https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/335

Part D – Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Maximum Marks:	**100**
Continuous Comprehensive Evaluation (CCE):	**40** Marks
University Exam (UE):	**60** Marks

Internal Assessment: Continuous Comprehensive Evaluation (CCE)	**Total Marks: 40**
External Assessment: University Exam (UE)	**Total Marks: 60**

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Part A – Introduction				
Program: 2-Year Post-Graduate Programme		**Class:** Post-Graduate I-Year (Semester – I)	**Year:** 2025	**Session:** 2025-2026
Subject: Mathematics				
1	Course Code			
2	Course Title	Topology – I (Theory)		
3	Course Type	CC – 12		
4	Pre-requisite (if any)	To study this course, a student must have had the subject Mathematics at Degree level (3 Year Degree Course).		
5	Course Learning Outcomes (CLO)	The course will enable the students to: 1. Determine interior, closure, boundary and limit points of metric space. 2. Determine interior, closure, boundary, limit points, basis and sub-basis of topological spaces. 3. Check whether a collection of subsets is a basis for a given topological spaces or not and determine the topology generated by a given basis. 4. Identify the continuous maps between two spaces and maps from a space into product space. 5. Determine common topological properties of given two spaces.		
6	Credit Value	5 Credits		
7	Total Marks	Max. Marks: 40 + 60	Min. Passing Marks: 40	

Part B – Content of the Course		
Total No. of Lectures (in hours per week): 5 hours per week **Total Lectures:** 75 hours		
Module	Topics	No. of Lectures
I	**Indian Knowledge System:** Contribution and biography of following Indian Mathematicians in Topology: Dr. M. S. Narasimhan, Dr. V. S. Varadarajan	02
II	**Metric Space:** Definition, examples and types of Metric spaces. Neighborhoods, Limit points, Interior points and Boundary points. Open and closed sets. Closure and interior of a set. Subspace of a Metric space. Sequences in a Metric space: Convergent sequence, Cauchy sequences. Completeness of a Metric space. Cantor's intersection theorem. Contraction principle. Dense subsets, Baire Category theorem. Continuous functions. ***Suggested Activities:*** *Discuss about the applications of Closure of a set, Interior points, Boundary points and Baire Category theorem.*	18

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III	**Topological Spaces:** Definition and examples of topological spaces. Neighbourhood of a point, limit point and derived set. Closed set and closure of a set. Dense set and nowhere dense set. Interior, exterior and boundary points of a set.	15
	Suggested Activities: *Discuss about the applications of Closure of a set, Interior, exterior and boundary points of a set in topological space.*	
IV	**Relative Topology and Bases:** Topological subspace and relative topology. Basis and subbasis. First and second countable spaces and separable spaces.	10
	Suggested Activities: *Discuss how Topological Subspaces be used in Computer graphics, GIS, robotics.*	
V	**Continuity and Homeomorphism:** Continuity in topological spaces, Sequential Continuity at a point, Open and closed functions, Homeomorphism of topological spaces, Topological property.	15
	Suggested Activities: *(i) Discuss application of Homeomorphism in Robotics. (ii) Discuss how Sequential Continuity be used in Machine Learning.*	
VI	**Connectedness:** Separated sets, Connected and Disconnected Sets, Continuity and Connectedness, Component of a space. Totally disconnected spaces, Locally connected spaces.	15
	Suggested Activities: *Discuss the applications of Separated Sets, Connected and Disconnected Sets to solve the real-world problems.*	

Keywords/Tags:
Metric Space, Topological Spaces, Continuity and Homeomorphism in topological spaces, Separable spaces in topological space.

Part C – Learning Resources

Text Books, Reference Books, Other Resources

Suggested Readings:

Text Books:

1. G. F. Simmons: Introduction to Topology and Modern Analysis, McGraw Hill Education, 2017.
2. J. R. Munkres: Topology, Pearson; 2nd edition, 2015.
3. मध्यप्रदेश हिन्दी ग्रंथ अकादमी की पुस्तकें।

Reference Books:

1. K. D. Joshi: Introduction to General Topology, New Age International Private Limited, 2017.
2. T. B. Singh, Elements of Topology, CRC Press, Taylor & Francis, 2013.
3. K. Chandrasekhara Rao: Topology, Narosa Publishing House, 2009.

Suggested Digital Platforms Web links:
https://www.eshiksha.mp.gov.in/mpdhe
https://epgp.inflibnet.ac.in

Suggested Equivalent online courses:
https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/335

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Part D – Assessment and Evaluation	
Suggested Continuous Evaluation Methods: Maximum Marks: 100 Continuous Comprehensive Evaluation (CCE): 40 Marks University Exam (UE): 60 Marks	
Internal Assessment: Continuous Comprehensive Evaluation (CCE)	**Total Marks: 40**
External Assessment: University Exam (UE)	**Total Marks: 60**

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Part A – Introduction				
Program: 2-Year Post-Graduate Programme		**Class:** Post-Graduate I-Year (Semester – I)	**Year:** 2025	**Session:** 2025-2026
Subject: Mathematics				
1	Course Code	Real Analysis (Theory)		
2	Course Title	CC – 13		
3	Course Type			
4	Pre-requisite (if any)	To study this course, a student must have had the subject Mathematics at Degree level (3 Year Degree Course).		
5	Course Learning Outcomes (CLO)	The course will enable the students to: 1. Learn the properties of Riemann and Riemann-Stieltjes integrable functions and applications of the fundamental theorems of integration. 2. Understand the concepts of convergence and term by term integration and differentiation of a power series. 3. Understanding and evaluating uniform convergence of series of real valued functions. 4. Analyzing the relation between uniform convergence and continuity, uniform continuity and differentiation and integration of sequences of real valued functions.		
6	Credit Value	5 Credits		
7	Total Marks	Max. Marks: 40 + 60	Min. Passing Marks: 40	

Part B – Content of the Course		
Total No. of Lectures (in hours per week): 5 hours per week **Total Lectures:** 75 hours		
Module	Topics	No. of Lectures
I	**Indian Knowledge System:** Contribution and biography of following Indian Mathematicians in Real Analysis: Dr. K. Chandrasekharan, Dr. D. S. Kothari	02
II	**Real Number System:** Introduction, Denseness property, Neighbourhood, Limit Points of a set, Open and Closed Set, Interior and Closure of a Set, Bolzano-Weierstrass Theorem. *Suggested Activities: Discuss Limit Points of a set, Open and Closed Set, Interior and Closure of a Set.*	5
III	**Riemann Integral, Integration and Differentiation:** Riemann Integral: Properties of Riemann sums, Riemann integrability, Properties of Riemann integrable functions, Riemann integration and continuity, Integral as a limit of sums. Integration and Differentiation:	15

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	Fundamental theorem of calculus, Mean value theorems of integral calculus, Integration by parts, Change of variables. ***Suggested Activities:*** *Understanding the properties of Riemann integrable functions and their applications.*	
IV	**Riemann-Stieltjes Integral:** Definition, existence and properties of Riemann-Stieltjes integral, Relation Between Riemann and Riemann-Stieltjes integral, Mean value theorem, Integration and differentiation, Fundamental theorem of calculus for Riemann-Stieltjes integral, Integration of vector valued functions, Rectifiable curves. ***Suggested Activities:*** *Gives the applications of Riemann-Stieltjes Integral in various fields.*	15
V	**Improper Integral and Fourier Series:** Improper integrals and their convergence: Comparison tests and μ-test, Abel's and Dirichlet's tests. Absolute and Conditional convergence of improper integrals, Frullani's integral as a function of a parameter, Differntiability & integrability of an integral of a function of a parameter, Fourier series for half and full intervals. ***Suggested Activities:*** *Discuss the application of Fourier Series in Signal Processing and Communications.*	18
VI	**Uniform Convergence and Power Series:** Pointwise and uniform convergence of sequences of functions: Cauchy's general principle of uniform convergence, Weierstrass M_n-Test, Uniform convergence of series of functions: Weierstrass M-test, Uniform convergence, continuity, differentiability and Riemann integrability. Algebra of power series: Uniform convergence of power Series, Uniqueness of power series, Abel's theorem, Properties of power series, Tauber's theorem. ***Suggested Activities:*** *Analyzing the relation between uniform convergence and continuity.*	20

Keywords/Tags:
Real Numbers, Riemann Integral, Riemann-Stieltjes Integral, Improper Integral, Fourier Series, Uniform Convergence, Power Series.

Part C – Learning Resources

Text Books, Reference Books, Other Resources

Suggested Readings:

Text Books:

1. Walter Rudin: Principles of Mathematical Analysis, McGraw Hill Education, Third edition, 2017.
2. S. C. Malik and Savita Arora: Mathematical analysis, New Age Publication. Delhi, 2017.
3. G. F. Simmons: Introduction to Topology and Modern Analysis, McGraw Hill Education, 2017.
4. Goldberg R R: Methods of Real Analysis, Oxford & IBH Publishing, 2020.
5. मध्यप्रदेश हिन्दी ग्रंथ अकादमी की पुस्तकें।

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	Fundamental theorem of calculus, Mean value theorems of integral calculus, Integration by parts, Change of variables. ***Suggested Activities:*** *Understanding the properties of Riemann integrable functions and their applications.*	
IV	**Riemann-Stieltjes Integral:** Definition, existence and properties of Riemann-Stieltjes integral, Relation Between Riemann and Riemann-Stieltjes integral, Mean value theorem, Integration and differentiation, Fundamental theorem of calculus for Riemann-Stieltjes integral, Integration of vector valued functions, Rectifiable curves. ***Suggested Activities:*** *Gives the applications of Riemann-Stieltjes Integral in various fields.*	15
V	**Improper Integral and Fourier Series:** Improper integrals and their convergence: Comparison tests and μ-test, Abel's and Dirichlet's tests. Absolute and Conditional convergence of improper integrals, Frullani's integral as a function of a parameter, Differntiability & integrability of an integral of a function of a parameter, Fourier series for half and full intervals. ***Suggested Activities:*** *Discuss the application of Fourier Series in Signal Processing and Communications.*	18
VI	**Uniform Convergence and Power Series:** Pointwise and uniform convergence of sequences of functions: Cauchy's general principle of uniform convergence, Weierstrass M_n-Test, Uniform convergence of series of functions: Weierstrass M-test, Uniform convergence, continuity, differentiability and Riemann integrability. Algebra of power series: Uniform convergence of power Series, Uniqueness of power series, Abel's theorem, Properties of power series, Tauber's theorem. ***Suggested Activities:*** *Analyzing the relation between uniform convergence and continuity.*	20
Keywords/Tags: Real Numbers, Riemann Integral, Riemann-Stieltjes Integral, Improper Integral, Fourier Series, Uniform Convergence, Power Series.		

Part C – Learning Resources
Text Books, Reference Books, Other Resources
Suggested Readings: **Text Books:** 1. Walter Rudin: Principles of Mathematical Analysis, McGraw Hill Education, Third edition, 2017. 2. S. C. Malik and Savita Arora: Mathematical analysis, New Age Publication. Delhi, 2017. 3. G. F. Simmons: Introduction to Topology and Modern Analysis, McGraw Hill Education, 2017. 4. Goldberg R R: Methods of Real Analysis, Oxford & IBH Publishing, 2020. 5. मध्यप्रदेश हिन्दी ग्रंथ अकादमी की पुस्तकें।

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Reference Books:

1. Santi Narayan and M. D. Raisighania: Elements of Real Analysis, S Chand, 2003.
2. J. R. Munkres: Topology, Pearson; 2nd edition, 2015.
3. D. Somasundaram and B. Choudhary: A First Course in Mathematical Analysis, Narosa Publishing House, 1996.

Suggested Digital Platforms Web links:

https://www.eshiksha.mp.gov.in/mpdhe
https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=25

Suggested Equivalent online courses:

https://nptel.ac.in/courses/111106142/
https://nptel.ac.in/courses/111106153/
https://nptel.ac.in/courses/111106141/

Part D – Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Maximum Marks:	**100**
Continuous Comprehensive Evaluation (CCE):	**40** Marks
University Exam (UE):	**60** Marks
Internal Assessment: Continuous Comprehensive Evaluation (CCE)	**Total Marks: 40**
External Assessment: University Exam (UE)	**Total Marks: 60**

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Part A – Introduction				
Program: 2-Year Post-Graduate Programme		**Class:** Post-Graduate I-Year (Semester – I)	**Year:** 2025	**Session:** 2025-2026
Subject: Mathematics				
1	Course Code			
2	Course Title	Complex Analysis (Theory)		
3	Course Type	CC – 14		
4	Pre-requisite (if any)	To study this course, a student must have had the subject Mathematics at Degree level (3 Year Degree Course).		
5	Course Learning Outcomes (CLO)	The course will enable the students to: 1. Visualize complex numbers as points of $\mathbb{R}^2$ and stereographic projection of complex plane on the Riemann sphere. 2. Recognize the significance of differentiability and analyticity of complex functions. 3. Use Cauchy-Goursat theorem and Cauchy integral formula in evaluation of contour integrals. 4. Apply Liouville's theorem in fundamental theorem of Algebra. 5. Learn Taylor and Laurent series expansions of analytic functions. 6. Classify the nature of singularity, poles and residues and apply Cauchy residue theorem.		
6	Credit Value	5 Credits		
7	Total Marks	Max. Marks: 40 + 60	Min. Passing Marks: 40	

Part B – Content of the Course		
Total No. of Lectures (in hours per week): 5 hours per week **Total Lectures:** 75 hours		
Module	Topics	No. of Lectures
I	**Indian Knowledge System:** Contribution and biography of following Indian Mathematicians in Complex Analysis: Dr. C. T. Rajagopal, Dr. S. Minakshisundaram	02
II	**Complex Number and Functions:** Introduction of complex numbers and their geometrical representation: Extended complex plane, Stereographic projection of complex numbers. Continuity and differentiability of complex functions, Analytic functions, Cauchy-Riemann equations, Harmonic functions, Polar form of Cauchy-Riemann equations. ***Suggested Activities:*** *Discuss the applications of Cauchy-Riemann equations and Harmonic functions.*	15

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III	**Complex Integration:** Definition and examples of complex integration, Absolute value of a complex integral, Cauchy's Theorem, Cauchy's-Goursat theorem, Cauchy's integral formula, Higher order derivatives, Morera's theorem, Cauchy's inequality, Liouville's theorem, Taylor's theorem, Laurent theorem. ***Suggested Activities:*** *Using Cauchy-Goursat theorem and Cauchy integral formula in evaluation of contour integrals.*	18
IV	**Poles, Zeros and Singularities:** Introduction of poles, zeros and singularities, Meromorphic function, Argument principle, Rouche's theorem, Fundamental theorem of algebra, Maximum modulus principle, Schwarz lemma. ***Suggested Activities:*** *Discuss the applications of Argument principle and Rouche's theorem.*	15
V	**Calculus of Residues:** Residue, Cauchy's Residue theorem, Evaluation of integrals: $\int_0^{2\pi} f(cos\theta, sin\theta)\, d\theta$, $\int_{-\infty}^{\infty} f(x)\, dx$, $cosmx$ and $sinmx$ as a factor in the integrand, Integration of many valued functions. ***Suggested Activities:*** *Discuss the applications of Calculus of Residues to solve various problems.*	15
VI	**Mobius Transformation and Conformal Mapping:** Mobius Transformation, their properties and classification, Conformal Mapping and their properties. ***Suggested Activities:*** *Real world applications of Mobius Transformation and Conformal Mapping.*	10

Keywords/Tags:
Complex Numbers, Complex Function, Complex Integration, Poles, Zeros, Singularities, Calculus of Residues, Mobius Transformation, Conformal Mapping.

Part C – Learning Resources

Text Books, Reference Books, Other Resources

Suggested Readings:

Text Books:

1. L. V. Alhfors: Complex Analysis, McGraw Hill Education; Third edition, 2017.
2. T. Pati: Functions of a Complex Variables, Pothishala Pvt. Ltd, 1986.
3. मध्यप्रदेश हिन्दी ग्रंथ अकादमी की पुस्तकें।

Reference Books:

1. Ponnuswamy S: Foundations of Complex Analysis, Alpha Science International Ltd, 2nd edition, 2005.
2. V. Karunakaran: Complex Analysis, Narosa Publication, 2005.
3. Kayalal Pachaiyappa: Complex Analysis, S. Chand and Company Ltd., 2014.

Suggested Digital Platforms/Web links:
https://www.eshiksha.mp.gov.in/mpdhe
https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=25

Suggested Equivalent online courses:

Name of BOS: Mathematics
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https://nptel.ac.in/courses/111106142/ https://nptel.ac.in/courses/111106153/ https://nptel.ac.in/courses/111106141/

Part D – Assessment and Evaluation	
Suggested Continuous Evaluation Methods: Maximum Marks: **100** Continuous Comprehensive Evaluation (CCE): **40** Marks University Exam (UE): **60** Marks	
Internal Assessment: Continuous Comprehensive Evaluation (CCE)	**Total Marks: 40**
External Assessment: University Exam (UE)	**Total Marks: 60**

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