SYLLABUS FOR

THE FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B.Sc. VII and VIII Semester

As per provision of NEP-2020

Implemented fromAcademic Year 2022 onwards

Session 2025-26

DEPARTMENT OF MATHEMATICS

GOVT. DIGVIJAY AUTONOMOUS P.G. COLLEGE,

RAJNANDGAON (C.G.)

B. Sc. (Multiple Major) – DEGREE WITH HONOURS COURSE
(Session 2025-26) Major - Mathematics

	SEMESTER	COURSE TYPE	Theory/ Practical	COURSE CODE	PAPER TITLE	CREDIT L	T	P	Max marks	ESE	IA
FOURTH YEAR	VII	DSC-VIIA	Theory		Advanced Abstract Algebra I	3	1	0	100	80	20
		DSE-VIIA	Theory		Advanced Real Analysis	3	1	0	100	80	20
		DSE – VIIIA	Theory		Topology	3	1	0	100	80	20
		DSE- IX A	Theory		Complex Analysis I	3	1	0	100	80	20
		GE	Theory		General Mathematics	3	1	0	100	80	20
	VIII	DSC-VIIIA	Theory		Advanced Abstract Algebra II	3	1	0	100	80	20
		DSE- X A	Theory		Measure Theory	3	1	0	100	80	20
		DSE- XI A	Theory		General and Algebraic Topology	3	1	0	100	80	20
		DSE- XII A	Theory		Complex Analysis II	3	1	0	100	80	20
		DSE- XIII A	Theory		Advanced Discrete Mathematics	3	1	0	100	80	20

ESE- End Semester Exam, IA-Internal Assessment

Instruction for Question paper setting

End Semester Exam (ESE) for DSC, DSE and GE

There will be 03 sections of question of 80marks

Section A- Section A will be very short answer type questions consisting 8 questions of 2 marks, two questions from each unit.

Section B- Section B will be short answer type questions consisting 4 questions of 6 marks each, one questions from each unit with internal choice.

Section C- Section C will be long answer (Descriptive) type questions consisting 4 questions of 10 marks each, one question from each unit with internal choice.

Minimum Pass Marks 40%

Section	Maximum Marks (80)	
A	2 x 8 = 16	Very short answer type questions consisting of 8 questions of 2 marks, two questions from each unit.
B	6 x 4 = 24	Short answer type questions consisting 4 questions of 6 marks each, one question fromeach unit with internal choice.
C	10 x 4 = 40	Long answer (Descriptive) typequestions consisting 4 questions of 10 marks each, one question from each unit with internal choice

B. Sc. (Multiple Major) – DEGREE WITH RESEARCH COURSE
(Session 2025-26) Major - Mathematics

	SEMESTER	COURSETYPE	Theory/ Practical	COURSE CODE	PAPER TITLE	CREDIT L	T	P	Max marks	ESE	IA
FOURTH YEAR	VII	DSC-VIIA	Theory		Advanced Abstract Algebra I	3	1	0	100	80	20
		DSE-VIIA	Theory		Advanced Real Analysis I	3	1	0	100	80	20
		DSE –VIIIA	Theory		Topology	3	1	0	100	80	20
		DSE- IX A	Theory		Complex Analysis I	3	1	0	100	80	20
		GE	Theory		General Mathematics	3	1	0	100	80	20
	VIII	DSC-VIIIA	Theory		Advanced Abstract Algebra II	3	1	0	100	80	20
		DSE- X A	Theory		Measure Theory / General and Algebraic Topology / Complex Analysis II / Advanced Discrete Mathematics	3	1	0	100	80	20
		Dissertation			Dissertation on Any Topic of Mathematics						

ESE- End Semester Exam, IA-Internal Assessment

Instruction for Question paper setting

End Semester Exam (ESE) for DSC, DSE and GE

There will be 03 sections of question of 80 marks

Section A- Section A will be very short answer type questions consisting 8 questions of 2 marks, two questions from each unit.

Section B- Section B will be short answer type questions consisting 4 questions of 6 marks each, one questions from each unit with internal choice.

Section C- Section C will be long answer (Descriptive) type questions consisting 4 questions of 10 marks each, one question from each unit with internal choice.

Minimum Pass Marks 40%

Section	Maximum Marks (80)	
A	2 x 8 = 16	Very short answer type questions consisting of 8 questions of 2 marks, two question from each unit.
B	6 x 4 = 24	Short answer type questions consisting 4 questions of 6 marks each, one question fromeach unit with internal choice.
C	10 x 4 = 40	Long answer (Descriptive) typequestions consisting 4 questions of 10 marks each, one question from each unit with internal choice

SYLLABUS OF 4 YEARS UG PROGRAM (FYUGP) IN MATHEMATICS, GOVT. DIGVIJAY AUTONOMOUS P G COLLEGE, RAJNANDGAON, AS PER NEP 2020 (SEMESTER-VII AND VIII)

Program Objective

PO1 It is to give foundation knowledge for the students to understand basic mathematics including applied aspect for the same.

PO2 It is to develop enhanced quantative skills and pursuing higher mathematics and research as well as.

PO3 Students will be able to develop solution –oriented approach towards various issues related to their environment.

PO4 Students will become employable in various governments, public and private sectors.

PO5 Scientific tempers in general and mathematical temper in particular will the developed in students.

PO6 Sufficient subject matter competence and enable students to prepare for various competitive examinations such as IIT-JAM, GATE, GRE, UGC-CSIR, NET/JRF and Civil Services Examinations

Program Specific Outcome (PSO)

PSO1 Student should be able to process recall basic idea about mathematics which can be displayed by them.

PSO2 Student should have adequate exposure to many aspects of mathematical sciences.

PSO3 Student is equipped with mathematical modeling ability, critical mathematical thinking and problem solving skill etc.

PSO4 Student should be able to apply their skills and knowledge in various fields of studies including science, engineering, commerce and management.

B.Sc. Fourth Year (MATHEMATICS)

Detailed Syllabus For

DEGREE with Honours/ Research IN MATHEMATICS

GOVT. DIGVIJAY AUTONOMOUS P.G. COLLEGE, RAJNANDGAON (C.G.)

B. Sc. (Multiple Major) - DEGREE WITH HONOURS COURSE and DEGREE WITH RESEARCH COURSE

(Session 2025-26)Major-Mathematics

Session: **2025-26**	Program: **B.Sc.**
Semester: **VII**	Subject: **Mathematics**
Course Type: **DSC-VIIA**	Course Code:
Course Title:	**ADVANCED ABSTRACT ALGEBRA -I**
Credit: **4**	Lecture: **60**
M.M. 100 = **(ESE 80+IA 20)**	Minimum Passing Marks: **40%**

Title	ADVANCED ABSTRACT ALGEBRA - I
Course LearningOutcome:	**This Course will enable the students to:** (i) Explain normal and subnormal series of groups. Explore composition series and apply the Jordan-Holder theorem. Identify and analyze solvable and nilpotent groups. (ii) Describe extension fields and distinguish algebraic and transcendental extensions. Analyze separable and inseparable extensions and explore their implications. (iii) Identify and explain perfect fields, finite fields, and apply them to various mathematical problems. Discuss primitive elements and their significance in field theory. Explore algebraically closed fields and their properties. (iv) Describe normal extensions, automorphisms of field extensions and their properties. Explain Galois extensions and their properties. Apply the Fundamental Theorem of Galois theory to relate field extensions and group structures. (v) Explain concept of solvability of polynomial by radicals. Express insolvability of the general equation of degree 5 by radicals. Observe limitations of solvability of certain polynomial by radicals.

Units	Lectures	Lectures (15 x 4 = 60)	Credit
		ADVANCED ABSTRACT ALGEBRA - I	
I	15	**Groups:** Normal and Subnormal Series, Composition Series, Jordan – Holder Theorem, Solvable Groups and its properties, Commutator subgroup, Nilpotent groups and its properties.	1
II	15	**Field Theory:** Extension Field, Finite extension, Algebraic element, Algebraic and Transcendental extensions, algebraically closed Fields, Roots of polynomials, Splitting field	1
III	15	Simple extension, Primitive element, Separable and inseparable extensions, Perfect Field, Finite Fields, Automorphisms of extensions, Normal extensions	1
IV	15	**Galois Theory:** Galois Extensions, Galois group Fundamental Theorem, Galois Theory. Solution of Polynomial equations, by Radicals, Insolvability of the general question of degree 5 by Radicals	1

List of Books	**Text Books Recommended :** 1. P.B.Bhattcharya, S.K.Jain,S.R Nagpaul:Basic Abstract Algebra,Cambris University Press. 2. I.N.Heristin: Topics In Algebra,Willy Easterm Ltd. 3. Quazi Zameeruddin and Surjeet Singh:Modern Algerbra. **Reference Books Recommended :** 1. M.Artin,Algebra,Prentice-Hall of India,1991. 2. P.M.Cohn,Algebra,Vols.I,II&III,John Willey & Sons,1982,1989,1991. 3. N. Jacobson, Basic Algebra,Vols.I,W.H.Freeman,1980(alsoPublished By Hindushtan Publishing Company). 4. S.Lang, Algebra, 3rd Edition, Addison-Wesely,1993. 5. I.S.Luther and I.B.S.Passi,Algebra,Vol.I-Groups,Vol.II-Rings,NarosaPublishing House (Vol.I- 1996, Vol. II-1999) 6. D.S.Malik,J.N.Mordeson,andM.K.Sen,Fundamental Of Abstract Algebra,MC Graw-Hill,International Edition,1997. 8. Vivek Sahai and vikas Bist,Algebra,Narosha Publishing House,1999. 9. I.Stewart,Galois Theory,2nd Edition,Chapman and Hall,1989. 10. J.P.Escofier,Galois Theory,GTM Vol.204,Springer,2001. 11. Fraleigh,A First Course In Algebra,Narosa,1982.
E-ressources	1. https://onlinecourses.nptel.ac.in 2. https://epqp.inflibnetaci.in 3. https://swavam.gov.in 4. https://www.mooc.org

GOVT. DIGVIJAY AUTONOMOUS P.G. COLLEGE, RAJNANDGAON (C.G.)

B. Sc. (Multiple Major) - DEGREE WITH HONOURS COURSE and DEGREE WITH RESEARCH COURSE

(Session 2025-26)Major-Mathematics

Session: **2025-26**	Program: **B.Sc.**
Semester: **VII**	Subject: **Mathematics**
Course Type: **DSE-VIIA**	Course Code:
Course Title:	**ADVANCED REAL ANALYSIS**
Credit: **4**	Lecture: **60**
M.M. 100 = **(ESE 80+IA 20)**	Minimum Passing Marks: **40%**

Title	ADVANCED REAL ANALYSIS
Course LearningOutcome:	**This Course will enable the students to:** (i) Understand the concept of functions of several variables and properties of sets of vectors in R^n. (ii) Understand the concept of maxima and minima of real valued functions from R to R and from R^n to R. (iii) Understand the concept of Integration theory that is closely related to the theory of Euclidean spaces and derivatives of functions of several variables. (iv) Understand the concept of convergence and divergence of power series and apply Abel's and Tauber's theorems.

Units	Lectures	Lectures (15 x 4 = 60)	Credit
		ADVANCED REAL ANALYSIS	
I	15	**Riemann-stieltjes integral:** Definition and Existence of Riemann-stieltjes integral, Properties of the Riemann- stieltjes integral, Integration and Differentiation, The Fundamental Theorem of calculus, Integration of Vector- valued Functions, Rectifiable Curves	1
II	15	Function of several variables, linear Transformations, Derivatives in an Open Subset of R^n Chain Rule, Partial, Deriavatives, Interchange of the order of differentiation, Derivatives of Higher Orders, Taylor's Theorem, Inverse Function Theorem, Implicit Function Theorem.	1
III	15	Jacobians, Extremum problem with Constraints, Lagrange's multiplier method, Differentiation of Integrals	1
IV	15	Power Series, Uniqueness theorem for Power Series,Abel's and Tauber's Theorem. Partitions of unity, Differential Forms, Stoke's Theorem	1

List of Books	**Text Books Recommended :** 1. Walter Rudin, principals Of Mathematical Analysis (3rd Edition).Mc Graw Hill, Kogakusha,1976, International Student edition **Reference Books Recommended :** 1. T.M. Apostol, Mathematical Analysis Narosa Publishing House, New Delhi, 1985. 2. Gabriel Klambauer, Mathematical Analysis Marcel Dekkar, Inc.NewYork, 1975. 3. A.J.White,Real Analysis,An Introduction,Addison-Wesley Publishing Co.,Inc.,1968 4. G.De Barra, Measure Theory In Integration,Wiley Esterm Limited,1981. 5. E.Hewitt and K.Stromberg. Real And Abstract Analysis,Berlin Springer,1969. 6. P.K.Jain and V.K.Gupta,Labesuge Measure And Integration,New age International(P) Limited Published,New Delhi,1986 Reprint 2000. 7. I.P.Natanson,Theory Of Function of a Real Variable.Vol.I,Frederick Unagar Publishing Co., 1961. 8. H.L.Royden,Real Analysis,Macmillan Pub.Co.Inc.4th Edition,Newyork,1962. 9. Richard L.Wheeden and Antoni Zygmund,Measure and Integral:An Introduction to Real Analysis, Marcel Dekkar Inc.,1977. 10. J.H.Williamson, Lebesgue Integration,Holt Rinchart and Winston,Inc.New York.1962. 11. A.Friendman, Foundation of Modern Analysis,Holt,RineHart and Winston,Inc.New York, 1970.
E-ressources	1. https://onlinecourses.nptel.ac.in 2. https://epqp.inflibnetaci.in 3. https://swavam.gov.in 4. https://www.mooc.org

GOVT. DIGVIJAY AUTONOMOUS P.G. COLLEGE, RAJNANDGAON (C.G.)

B. Sc. (Multiple Major) – DEGREE WITH HONOURS COURSE and DEGREE WITH RESEARCH COURSE

(Session 2025-26)Major -Mathematics

Session: **2025-26**	Program: **B.Sc.**
Semester: **VII**	Subject: **Mathematics**
Course Type: **DSE-VIII A**	Course Code:
Course Title:	**TOPOLOGY**
Credit: **4**	Lecture: **60**
M.M. 100 = **(ESE 80+IA 20)**	Minimum Passing Marks: **40%**

Title	TOPOLOGY
Course LearningOutcome:	**This Course will enable the students to:** (i) 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. (ii) Understand the concept of countable, separable spaces and separation axioms with their characterizations and basic properties. (iii) Understand the concept and properties of compactness, continuous functions. (iv) Understand the concept and properties of countable compactness in metric spaces. (v) Understand the concept and properties of connectedness, continuous functions.

Units	Lectures	Lectures (15 x 4 = 60)	Credit
		TOPOLOGY	
I	15	**Topological Space :** Cardinal numbers and its arithmetic, Definition and examples of topological spaces, Neighbourhood Systems, Limit point, Derived sets and closed sets, Interior, Exterior and Frontier points, Bases and sub-bases, Alternate methods of defining a topology in terms of Kuratowski Closure Operator, Subspaces and relative topology.	1
II	15	**Continuous function of Topological space:** Continuous functions and homeomorphism, First and Second Countable spaces, Lindelof's theorems, Separable spaces, Second countability and separability.	1
III	15	**Compactness and Connectedness:** Compactness, Continuous functions and compact sets, Basic properties of Compactness, Compactness and finite intersection property, Sequentially and countably compact sets, Local compactness, Connected spaces, Connectedness on the real line, Components, Locally connected spaces, Totally connected spaces.	1
IV	15	**Separation axioms:** Separation axioms: T_0, T_1, T_2, T_3 spaces, Basic properties	1

Separation Axioms T_0, T_1, T_2, T_3, T_4 Spaces, Basic Properties Urysohn's Lemma, Tietze Extension theorem, T_5 spaces and

		Tychonoff spaces.	

List of Books	**Text Books Recommended :** 1. Introduction to General Topology By K.D.Joshi, Wiley Eastern Ltd., 1983. 2. Topology, A First Course By James R. Munkres, Prentice Hall of India Pvt. Ltd., New Delhi,2000. **References Books Recommended :** 1. J. Dugundji, Topology, Allyn and Bacon, 1966 (reprinted in India by Prentice Hall of India Pvt. Ltd.). 2. George F.Simmons, Introduction to Topology and modern Analysis, McGraw-Hill Book Company 3. J.Hocking and G Young, Topology, Addison-Wiley Reading, 1961. 4. J.L. Kelley, General Topology, Van Nostrand, Reinhold Co., New York,1995. 5. L. Steen and J. Seebach, Counter examples in Topology, Holt, Rinehart and Winston, New York, 1970. 6. W.Thron, Topologically Structures, Holt, Rinehart and Winston, New York,1966. 7. N. Bourbaki, General Topology Part I (Transl.),Addison Wesley, Reading, 1966. 8. R. Engelking, General Topology, Polish Scientific Publishers, Warszawa, 1977. 9. W. J. Pervin, Foundations of General Topology, Academic Press Inc. New York,1964. 10. E.H.Spanier, Algebraic Topology, McGraw-Hill, New York,1966. 11. S. Willard, General Topology, Addison-Wesley, Reading, 1970.
E-ressources	1. https://onlinecourses.nptel.ac.in 2. https://epqp.inflibnetaci.in 3. https://swavam.gov.in 4. https://www.mooc.org

GOVT. DIGVIJAY AUTONOMOUS P.G. COLLEGE, RAJNANDGAON (C.G.)

B. Sc. (Multiple Major) - DEGREE WITH HONOURS COURSE and DEGREE WITH RESEARCH COURSE

(Session 2025-26)Major-Mathematics

Session: **2025-26**	Program: **B.Sc.**
Semester: **VII**	Subject: **Mathematics**
Course Type: **DSE-IX A**	Course Code:
Course Title:	**COMPLEX ANALYSIS - I**
Credit: **4**	Lecture: **60**
M.M. 100 = **(ESE 80+IA 20)**	Minimum Passing Marks: **40%**

Title	COMPLEX ANALYSIS - I
Course LearningOutcome:	**This Course will enable the students to:** (i) Understand Complex number and their properties. (ii) Learn about properties of linear transformation and isomorphism theorems. (iii) Understand the concept of Limit, Continuity, Differentiability of Complex and Analytic function. (iv) Obtain various variants of Mobius transformations. (v) Obtain various Conformal mapping and types of transformations.

Units	Lectures	Lectures (15 x 4 = 60)	Credit
		COMPLEX ANALYSIS - I	
I	15	**Complex Numbers and Their Geometrical Representation:** Complex numbers as ordered pairs, Geometrical representation of complex numbers, Modulus and argument of complex numbers and its Properties, Equation of straight line and circle, Cauchy's inequality and Lagrange's identity.	1
II	15	**Continuity and Differentiability of Complex and Analytic Functions:** Limit, Continuity, Differentiability of functions of a Complex variables, Analytic function, Cauchy — Riemann equations, Conjugate function, Laplace's Differential equations, Harmonic functions, Orthogonal system and Construction of Analytic function.	1
III	15	**Mobius Transformation:** Jacobian of Transformation, Linear Transformation, Mobius Transformation, Linear Group, Fixed point of Mobius transformation, Cross ratio, Inverse Point, Properties of Mobius transformation.	1
		Conformal Mappings: Conformal mapping, Necessary and sufficient condition for w =	

Conformal mapping Necessary & sufficient condition for $w = f(z)$ to represent a conformal mapping, Transformation $w = f(z)$

		Inverse, exponential, logarithmic and trigonometrical transformation.	

List of Books	**Text Books Recommended :** **1.** Complex Analysis By L.V. Ahlfors, McGraw - Hill, 1979. 2. J.B.Conway, Functions of one Complex variable, Springer-Verlag, International student- Edition, Narosa Publishing House, 1980. 3. H.K. Pathak, Complex Analysis and Applications, ShikshaSahityaPrakashan , 2019 **Reference Books Recommended :** **1.** H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford 1990. 2. Complex Function Theory By D.Sarason 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. D. Sarason, Complex Function Theory, Hindustan Book Agency, Delhi, 1994. 6. Mark J. Ablowitz and A.S. Fokas, Complex Variables: Introductio and Applications, Cambridge University press, South Asian Edition, 1998. 7. C.Caratheodory, Theory of Functions (2 Vols.) Chelsea Publishing Company, 1964. 8. E.0.Titchmarsh, The Theory of Functions, Oxford University Press, London. 9. S.Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.
E-ressources	1. https://onlinecourses.nptel.ac.in 2. https://epqp.inflibnetaci.in 3. https://swavam.gov.in 4. https://www.mooc.org

GOVT. DIGVIJAY AUTONOMOUS P.G. COLLEGE, RAJNANDGAON (C.G.)

B. Sc. (Multiple Major) – DEGREE WITH HONOURS COURSE
and DEGREE WITH RESEARCH COURSE

Session 2025-26

(For students of Science stream who have not chosen Mathematics as one of the DSC Course)

Session: **2025-26**	Program: **B.Sc.**
Semester: **VII**	Subject: **Mathematics**
Course Type: **GE-IA (Theory)**	Course Code:
Course Title:	**GENERAL MATHEMATICS**
Credit: **4**	Lecture: **60**
M.M. 100 = (ESE 80+IA 20)	Minimum Passing Marks: **40%**

Title	GENERAL MATHEMATICS
Course Learning Outcome:	**This Course will enable the students to:** 1. Learn to solve system of linear equations. 2. Solve the system of homogeneous and non homogeneous m linear equations by using the concept of rank of matrix, finding eigen values and eigenvectors 3. Students will be familiar with the techniques of differentiation of function with real variables 4. Identify and apply the intermediate value theorems and L'Hospital

Units	Lectures	Lectures (15 x 4 = 60)	Credits
I	15	**Matrices** Recapitulation of Symmetric and Skew Symmetric matrices, Algebra of Matrices; Row and column reduction, Echelon form. Rank of a matrix; Inverse of a matrix by elementary operations; Solution of system of linear equations; Criteria for existence of non- trivial solutions of homogeneous system of linear equations	
II	15	**Application of Matrices** Solution of system of linear equations; Criteria for existence of non-trivial solutions of homogeneous system of linear equations. Solution of non-homogeneous system of linear equations. Eigen values and Eigen vectors of square matrices, Cayley-Hamilton theorem, inverse of matrices by Cayley-Hamilton theorem (Without Proof).	1
III	15	**Differential Calculus** Limits, Continuity, Differentiability and properties. Intermediate value theorem, Rolle's Theorem, Lagrange's Mean Value theorem, Cauchy's Mean value theorem (Without Proof). and examples. Taylor's theorem, Maclaurin's series, Indeterminate forms (Without Proof). and examples.	1
IV	15	**Successive Differentiation** nth Derivatives of Standard functions $eax+b$,$(ax+b)n$, $\log(ax+b)$,$\sin(ax+b)$,$\cos(ax+b)$,$e^{ax}\sin(bx+c)$,$e^{ax}\cos(bx+c)$,Leibnitz theorem(Without Proof) and its applications.	1

List of Books

1. University Algebra - N.S. Gopala Krishnan, New Age International (P)Limited, 2015
2. Theory of Matrices - B S Vatsa, New Age International Publishers, 2010.
3. Matrices - A R Vasista, Krishna Prakashana Mandir, 2014.

	6. Calculus – Lipman Bers, Holt, Rinehart &Winston, 1969. 7. Calculus - S Narayanan & T. K. Manicavachogam Pillay, S. Viswanathan Pvt. Ltd., vol. I &II, 2009. 8. Suggestive digital platforms web links: NPTEL/SWAYAM/MOOCS

GOVT. DIGVIJAY AUTONOMOUS P.G. COLLEGE, RAJNANDGAON (C.G.)

B. Sc. (Multiple Major) – DEGREE WITH HONOURS COURSE and DEGREE WITH RESEARCH COURSE

(Session 2025-26)Major -Mathematics

Session: **2025-26**	Program: **B.Sc.**
Semester: **VIII**	Subject: **Mathematics**
Course Type: **DSC-VIIIA**	Course Code:
Course Title:	**ADVANCED ABSTRACT ALGEBRA II**
Credit: **4**	Lecture: **60**
M.M. 100 = **(ESE 80+IA 20)**	Minimum Passing Marks: **40%**

Title	ADVANCED ABSTRACT ALGEBRA II
Course LearningOutcome:	**This Course will enable the students to:** (i) Illustrare 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. (ii) Describe algebraic properties of linear transformations, calculate characteristic roots. Relate matrices and linear transformations. Solve problems involving linear transformations and matrices. (iii) Explain similarity of linear transformations, invariant subspaces. Perform reduction to triangular forms. Illustrate properties of nilpotent transformations. Apply the primary decomposition theorem. (iv) 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. (v) Evaluate and apply rational canonical form and generalized Jordan form over any field. Analyze linear transformations, matrices, and modules to determine their canonical forms.

Units	Lectures	Lectures (15 x 4 = 60)	Credit
		ADVANCED ABSTRACT ALGEBRA II	
I	15	**Modules:** Cyclic modules. Simple modules, Semi-Simple modules Schedular's Lemma, Free modules, Noetherian and Artinian modules and rings Hilbert basis Theorem,Wedderburn Artin Theorem, Uniform modules, Primary modules, and Noether- Lasker Theorem.	1
II	15	**Linear Transformations:** Algebra of Linear Transformations, characteristic roots, matrices and linear transformations.	1
		Canonical Form: 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 Jordon forms	
IV	15	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, rational canonical form, Generalized Jordan form over and field	1

List of Books	**Text Books Recommended :** 1. P.B.Bhattcharya,S.K.Jain,S.R Nagpaul:Basic Abstract Algebra,Cambris University Press. 2. I.N.Heristin:Topics In Algebra,Willy Easterm Ltd. 3. Quazi Zameeruddin and Surjeet Singh:Modern Algerbra. **References Books Recommended :** 1. M.Artin, Algebra, Prentice-Hall of India, 1991. 2. P.M.Cohn,Algebra,Vols.I ,II &III,John Willey & Sons,1982,1989,1991. 3. N.Jacobson,Basic Algebra,Vols.I,W.H.Freeman,1980(Published By Hindustan Publishing Company). 4. S.Lang, Algebra, 3rd Edition, Addison-Wesely,1993. 5. I.S.Luther and I.B.S. Passi, Algebra,Vol.I- Groups, Vol.II-Rings, NarosaPublishing House (Vol.I- 1996, Vol. II-1999) 6.D.S.Malik, J.N.Mordeson,andM.K.Sen,Fundamental Of Abstract Algebra, MC Graw-Hill,International Edition,1997. 7.Vivek Sahai and vikas Bist,Algebra,Narosha Publishing House,1999.
E-ressources	1. https://onlinecourses.nptel.ac.in 2. https://epqp.inflibnetaci.in 3. https://swavam.gov.in 4. https://www.mooc.org

GOVT. DIGVIJAY AUTONOMOUS P.G. COLLEGE, RAJNANDGAON (C.G.)

B. Sc. (Multiple Major) - DEGREE WITH HONOURS COURSE and DEGREE WITH RESEARCH COURSE

(Session 2025-26)Major -Mathematics

Session: **2025-26**	Program: **B.Sc.**
Semester: **VIII**	Subject: **Mathematics**
Course Type: **DSE-XA**	Course Code:
Course Title:	**MEASURE THEORY**
Credit: **4**	Lecture: **60**
M.M. 100 = **(ESE 80+IA 20)**	Minimum Passing Marks: **40%**

Title	MEASURE THEORY
Course LearningOutcome:	**This Course will enable the students to:** (i) Describe Lebesgue outer measure and its properties. Analyze measurable functions, explain concepts of Borel and Lebesgue measurability, including nonmeasurable sets. Integrate non-negative functions and series. (ii) Explain measures and outer measures, their properties and applications. Describe extension of a measure, the uniqueness of extension and completion of a measure. Apply integration with respect to a measure, including Riemann and Lebesgue integrals. (iii) Analyze the four derivatives, apply Lebesgue Differentiation Theorem, explore its implications in connecting differentiation and integration. Explain functions of bounded variation, their properties and applications.

Units	Lectures	Lectures (15 x 4 = 60)	Credit
		MEASURE THEORY	
I	15	**Measurable Sets:** Lebesgue outer measure, Lebesgue measure, Properties of measurable sets, Borel sets and their measurability characterization of measurable sets, Non measurable set.	1
II	15	**Measurable Function:** Definition and properties, Simple, Step and characteristics function, Continuous function, sets of measure Zero. Sequence of functions, Egoroffs theorem structure of measurable function, Lusin theorem, Frechet theorem, Convergence in measure, Riesz theorem.	1
III	15	**Lebesgue Integral:** Lebesgue integral of a bounded function, 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.	1
IV	15	**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	1

List of Books	**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. 1. Richard L. Wheeden and AntoniZygmund, 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 3. 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. 4. K.R. Parthasarathy, Introduction to Probability and Measure, Macmillan Company of India Ltd., Delhi, 1977. 5. R.G. Bartle, The Elements of Integration, John Wiley & Sons, Inc. New York, 1966.
E-ressources	1. https://onlinecourses.nptel.ac.in 2. https://epqp.inflibnetaci.in 3. https://swavam.gov.in 4. https://www.mooc.org

GOVT. DIGVIJAY AUTONOMOUS P.G. COLLEGE, RAJNANDGAON (C.G.)

B. SC. (Multiple Major) – DEGREE WITH HONOURS COURSE and DEGREE WITH RESEARCH COURSE

(Session 2025-26)Major -Mathematics

Session: **2025-26**	Program: **B.Sc.**
Semester: **VIII**	Subject: **Mathematics**
Course Type: **DSE-XA**	Course Code:
Course Title:	**GENERAL AND ALGEBRAIC TOPOLOGY**
Credit: **4**	Lecture: **60**
M.M. 100 = **(ESE 80+IA 20)**	Minimum Passing Marks: **40%**

Title	GENERAL AND ALGEBRAIC TOPOLOGY
Course LearningOutcome:	(i) Understand the concept of products in different topological spaces. (ii) Understand embedding, metrization and its related theorems. (iii) Understand the concept of net, filter and its various topological properties and their inter-relations. (iv) Understand fundamental group and covering spaces.

Units	Lectures	Lectures (15 x 4 = 60)	Credit
		GENERAL AND ALGEBRAIC TOPOLOGY	
I	15	**Product Topology** Tychonoff product topology; Separation axioms and product spaces; Compactness and product spaces; Connectedness and product spaces; Countability and product spaces. IV The fundamental group and Covering spaces Homotopy of paths; The fundamental group; Covering Spaces; The fundamental group of the circle and the fundamental theorem of algebra.	1
II	15	**Embedding and metrization** Embedding lemma and Tychonoff embedding. The Urysohn metrization theorem. Metrization theorems and Paracompactness-Local finiteness. The Nagata-Smirnov metrization theorem. Para compactness. The Smirnov metrization theorem.	1
III	15	**Nets and filter** Topology and convergence of nets.Hausdorffness andnets. Compactness and nets. Filters and their convergence. Canonical way of converting nets to filters and vice-versa. Ultra-filters and Compactness.	1
IV	15	**The fundamental group and Covering spaces** Homotopy of paths; The fundamental group; Covering Spaces; The fundamental group of the circle and the fundamental theorem of algebra	1

List of Books	**Text Books Recommended :** 1. Introduction to General Topology By K.D.Joshi, Wiley Eastern Ltd., 1983. 2. Topology, A First Course By James R. Munkres, Prentice Hall of India Pvt. Ltd., New Delhi,2000. **References Books Recommended :** 1. J. Dugundji, Topology, Allyn and Bacon, 1966 (reprinted in India by Prentice Hall of India Pvt. Ltd.). 2. George F.Simmons, Introduction to Topology and modern Analysis, McGraw-Hill Book Company 3. J.Hocking and G Young, Topology, Addison-Wiley Reading, 1961. 4. J.L. Kelley, General Topology, Van Nostrand, Reinhold Co., New York,1995. 5. L. Steen and J. Seebach, Counter examples in Topology, Holt, Rinehart and Winston, New York, 1970. 6. W.Thron, Topologically Structures, Holt, Rinehart and Winston, New York,1966. 7. N. Bourbaki, General Topology Part I (Transl.),Addison Wesley, Reading, 1966. 8. R. Engelking, General Topology, Polish Scientific Publishers, Warszawa, 1977. 9. W. J. Pervin, Foundations of General Topology, Academic Press Inc. New York,1964. 10. E.H.Spanier, Algebraic Topology, McGraw-Hill, New York,1966. 11. S. Willard, General Topology, Addison-Wesley, Reading, 1970.
E-ressources	1. https://onlinecourses.nptel.ac.in 2. https://epqp.inflibnetaci.in 3. https://swavam.gov.in 4. https://www.mooc.org

GOVT. DIGVIJAY AUTONOMOUS P.G. COLLEGE, RAJNANDGAON (C.G.)

B. Sc. (Multiple Major) - DEGREE WITH HONOURS COURSE and DEGREE WITH RESEARCH COURSE

(Session 2025-26)Major -Mathematics

Session: **2025-26**	Program: **B.Sc.**
Semester: **VIII**	Subject: **Mathematics**
Course Type: **DSE-XI A**	Course Code:
Course Title:	**COMPLEX ANALYSIS -II**
Credit: **4**	Lecture: **60**
M.M. 100 = **(ESE 80+IA 20)**	Minimum Passing Marks: **40%**

Title	**COMPLEX ANALYSIS-II**
Course LearningOutcome:	**This Course will enable the students to:** (i) Understand the fundamental Complex integration. Understand the concept of residues and apply Cauchy's residue theorem to evaluate integrals. (ii) Understand the concept of conformal mappings, bilinear transformations, their properties and classifications. Understand the concept about the spaces of analytic functions. (iii) Understand the concept of Weierstrass' factorization theorem, Riemann Zeta function, Gamma function and its properties. Understand the concept of Analytic Continuation and its properties. Gain knowledge of power series of analytic function. Understand the concept and properties of Harmonic functions on a disc. (iv) Understand the concept of Canonical products, entire function and exponent of Convergence.

Units	Lectures	Lectures (15 x 4 = 60)	Credit
		COMPLEX ANALYSIS-II	
I	15	**Complex integration:** 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. Maximum modulus principle. Schwarz lemma. The argument principle. Rouche'stheorem Inverse function theorem.	1
II	15	**Calculus of Residues:** Residues. Cauchy's residue theorem. Evaluation of integrals. Branches of many valued functions with special reference to argz, logz and z^a. Bilinear transformations, their properties and classifications. Definitions and examples of Conformal mappings. Spaces of analytic functions. Hurwitz's theorem. Montel's theorem Riemann mapping theorem	1
III	15	**Entire Functions and Analytic Continuation**: Weierstrass' factorisation theorem. Gamma function and its properties. Riemann Zeta function. Riemann's functional equation. Runge's theorem. Mittag-Leffler's theorem. Analytic Continuation. Uniqueness of direct analytic continuation. Uniqueness of analytic continuation along a curve. Power	1

series method of Analytic, Schwarz Reflection Principle, Monodromy theorem and its application

IV	15	**Harmonic Functionand Canonical products**: Harmonic functions on a disk. Harnack's inequality and theorem. Dirichlet Problem. Green's function, Canonical products. Jensen's formula. Poisson-Jensen formula. Hadamard's three circles theorem. Order of an entire function. Exponent of Convergence. Borel's theorem. Hadamard's factorization theorem.	1

List of Books	**Text Books Recommended :** 1. Complex Analysis By L.V. Ahlfors, McGraw - Hill, 1979. 2. J.B.Conway, Functions of one Complex variable, Springer-Verlag, International student- Edition, Narosa Publishing House, 1980. 3. H.K. Pathak, Complex Analysis and Applications, ShikshaSahityaPrakashan , 2019 **Reference Books Recommended :** 1. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford 1990. 2. Complex Function Theory By D.Sarason 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. D. Sarason, Complex Function Theory, Hindustan Book Agency, Delhi, 1994. 6. Mark J. Ablowitz and A.S. Fokas, Complex Variables: Introductio and Applications, Cambridge University press, South Asian Edition, 1998. 7. C.Caratheodory, Theory of Functions (2 Vols.) Chelsea Publishing Company, 1964. 8. E.0.Titchmarsh, The Theory of Functions, Oxford University Press, London. 9. S.Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.
E-ressources	1. https://onlinecourses.nptel.ac.in 2. https://epqp.inflibnetaci.in 3. https://swavam.gov.in 4. https://www.mooc.org

GOVT. DIGVIJAY AUTONOMOUS P.G. COLLEGE, RAJNANDGAON (C.G.)

B. Sc. (Multiple Major) – DEGREE WITH HONOURS COURSE and DEGREE WITH RESEARCH COURSE

(Session 2025-26)Major -Mathematics

Session: **2025-26**	Program: **B.Sc.**
Semester: **VIII**	Subject: **Mathematics**
Course Type: **DSE-XIIA**	Course Code:
Course Title:	**ADVANCED DISCRETE MATHEMATICS**
Credit: **4**	Lecture: **60**
M.M. 100 = **(ESE 80+IA 20)**	Minimum Passing Marks: **40%**

Title	ADVANCED DISCRETE MATHEMATICS
Course LearningOutcome:	(i) 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. (ii) Analyze homomorphisms on semigroups and monoids, apply congruence relations, construct quotient semigroups. Describe direct products in semigroups and monoids. (iii) Analyze homomorphisms on semigroups and monoids, apply congruence relations, construct quotient semigroups. Describe direct products in semigroups and monoids. (iv) 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. (v) Analyze 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.

Units	Lectures	Lectures (15 x 4 = 60)	Credit
		ADVANCED DISCRETE MATHEMATICS	
I	15	**Formal Logic**-Statements.Symbolic Representation and Tautologies.Quantifiers, Predicates and validity, Propositional Logic,Semigroups and Monoids-Definitions and Examples of semigroups monoids (Including those pertaining to concatenation Operation).Homomorphism of Semi groups and monoids, Congruence relation and Quotient Semi groups, Sub Semi Groups and submonoids. Direct Products.Basic Homomorphism Theorem	1
II	15	Lattices-Lattice as Partially ordered set	

their properties, Lattice and Algebraic system, sublattice, Homomorphism, some special

		lattices e.g. Complete, Complemented and Distributive Lattices. Boolean Algebras- Boolean Algebras as Lattice.Various Boolean Identities, The Switching Algebra example, Sub algebras.	1
III	15	**Direct Products and Homomorphisms Join-** Irreducible elements, Atoms and Minterms, Boolean Forms and their Equivalence, Minterm and 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.	1
IV	15	**Grammars and Languages**-Phrase- Structure Grammars, Rewriting Rules, Derivation,Sentential Forms.Language generated by a Grammar. Regular, context Free and Context Sensutuve Grammars and Languages.Regular sets Regular Expressions and The Pumping Lemma. Kleene's Theorem Notions of Syntax Analysis, Polish Notations Conversions of Infix Expression to Polish Notation, The Reverse Polish Notation	1

List of Books	**Text Books Recommended :** 1. Elements of Discrete Mathematics By C.L.Liu 2. J.P.Tramblay & Monohar, Discrete Mathematical Structures with Applications of Computer Science, Mc-Graw Hill Book Co., 1997 **References Books Recommended :** 1. J.L.Gersting, Mathematical Structures for Computer Science,(3rd edition), Computer Science Press, New York. 2. Seymour Lepschutz, Finite Mathematics (International Edition 1983), Mc-Graw Hill Book Company New York. 2. S.Witala , Discrete Mathematics-A Unified Approach Mc-Graw Hill Book Co.
E-ressources	1. https://onlinecourses.nptel.ac.in 2. https://epqp.inflibnetaci.in 3. https://swavam.gov.in 4. https://www.mooc.org