Shri Vile Parle Kelavani Mandal's

[I]ITHIBAI COLLEGE OF ARTS, CHAUHAN INSTITUTE OF SCIENCE & AMRUTBE JIVANLAL COLLEGE OF COMMERCE AND ECONOMICS (AUTONOMOUS)

NAAC Reaccredited 'A' grade, CGPA: 3.57 (February 2016),
Granted under RUSA, FIST-DST & -Star College Scheme of DBT, Government of India,
Best College (2016-17), University of Mumbai

Affiliated to the

UNIVERSITY OF MUMBAI

Program: M.Sc. Mathematics

Course: Semester III & IV

Choice Based Credit System (CBCS) with effect from the Academic year 2021- 2022

Evaluation Pattern

The performance of the learner will be evaluated in two components. The first component will be a Continuous Assessment with a weightage of 25% of total marks per course. The second component will be a Semester end Examination with a weightage of 75% of the total marks per course. The allocation of marks for the Continuous Assessment and Semester end Examinations is as shown below:

a) Details of Continuous Assessment (CA)

25% of the total marks per course:

Continuous Assessment	Details	Marks
Component 1 (CA-1)	Class Test	15 marks
Component 2 (CA-2)	Assignment	10 marks

b) Details of Semester End Examination

75% of the total marks per course. Duration of examination will be two and half hours.

Question Number	Description	Marks	Total Marks
1	UNIT I	15	15
2	UNIT II	15	15
3	UNIT III	15	15
4	UNIT IV	15	15
5	UNIT I,II,III,IV	15	15
		Total Marks	**75**

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

DEPARTMENT OF MATHEMATICS

M.Sc. SEMESTER III

Program: M.Sc .(2021-22)	**Semester: III**
Course: ALGEBRA III	**Course Code: PSMAMT301**

Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	NIL	1	5	25	75

Learning Objectives:

(1) Develop the knowledge of fundamental aspects and a clear perception of immense power of mathematical ideas

(2) helps to do the comparative study of various algebraic structures

Course Outcomes:

After completion of the course, learners would be able to:

CO1: apply sylow theory to study the properties of group and its sylow subgroups (Application).

CO2: apply Jordan Holder theorem to study the group and its composition series in detail(Application).

CO3: evaluate the number of Abelian groups of any given order using structure theorem (Evaluation).

CO4: explore the similarities and differences between the two algebraic structures vectorspace over the field and Module over the ring.(Analysis).

CO5: Understand the Linear representations of a finite group on a finite dimensional vector space over C (Understanding).

CO6: Apply the theory of modules to solve the problems based on weaker algebraic structure.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	Groups	15
2	Representation of finite groups	15
3	Modules	15
4	Modules over PID	15
	Total	**75**

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

PRACTICAL I
(If applicable)

Unit	Topic	No. of Hours/Credits
Module 1	Simple groups, A5 is simple. Solvable groups, Solvability of all groups of order less than 60, Nilpotent groups, Zassenhaus Lemma, Jordan-Holder theorem, Direct and Semi-direct products, Examples such as 5 (i) The group of affine transformations x 7→ ax + b as semi-direct product of the group of linear transformations acting on the group of translations. (ii) Dihedral group D2n as semi-direct product of Z2 and Zn. Classification of groups of order 12. (Ref: M. Artin, Algebra)	**15**
Module 2	Linear representations of a finite group on a finite dimensional vector space over C. If ρ is a representation of a finite group G on a complex vector space V, then there exits a G-invariant positive definite Hermitian inner product on V. Complete reducibility (Maschke's theorem). The space of class functions, Characters and Orthogonality relations. For a finite group G, there are finitely many isomorphism classes of irreducible representations, the same number as the number of conjugacy classes in G. Two representations having same character are isomorphic. Regular representation. Schur's lemma and proof of the Orthogonality relations. Every irreducible representation over C of a finite Abelian group is one dimensional. Character tables with emphasis on examples of groups of small order. Reference for Unit II: 1. M. Artin, Algebra, Prentice Hall of India. 2. S. Sternberg, Group theory and Physics, Cambridge University Press,.	**15**
Module 3	Modules over rings, Submodules. Module homomorphisms, kernels. Quotient modules. Isomorphism theorems. (ref:D.S. Dummit and R.M. Foote, Abstract Algebra) Generation of modules, finitely generated modules, (internal) direct sums and equivalent conditions. (ref:D.S. Dummit and R.M. Foote, Abstract Algebra) Free modules, free module of rank n. For a commutative ring R, Rn is isomorphic to Rm if and only if	**15**

	n = m. Matrix representations of homomorphisms between free modules of finites ranks. (Ref: N. Jacobson, Basic Algebra, Volume 1.) Dimension of a free module over a P.I.D. (ref: S. Lang, Algebra).	
Module 4	Noetherian modules and equivalent conditions. Rank of an R-module. Torsion submodule Tor(M) of a module M, torsion free modules, annihilator ideal of a submodule. (ref:D.S. Dummit and R.M. Foote, Abstract Algebra) Finitely generated modules over a PID: If N is a submodule of free module M (over a P.I.D.) of finite rank n, then N is free of rank $m \leq n$. Any submodule of a finitely generated module over a P.I.D. is finitely generated. (ref: S. Lang, Algebra) Structure theorem for finitely generated modules over a PID: Fundamental theorem, Existence (Invariant Factor Form and Elementary Divisor Form), Fundamental theorem, Uniqueness. Applications to the Structure theorem for finitely generated Abelian groups and linear operators. (ref:D.S. Dummit and R.M. Foote, Abstract Algebra)	15

Suggested Readings

1. D.S. Dummit and R.M. Foote, Abstract Algebra
2. S. Lang, Algebra
3. S. Sternberg, Group theory and Physics, Cambridge University Press,.

Program: M.Sc . (2021-22)				**Semester: III**	
Course: Functional Analysis				**Course Code: PSMAMT 302**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	0	1	5	25	75

Learning Objectives:

(1) Give the students a sufficient knowledge of fundamental principles of Functional analysis

(2) Reflecting the broad nature of the subject and developing mathematical tools for continuing further study in various fields of science.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Student will learn about Baire spaces, Hilbert spaces.

C02: Learn about Normal Linear spaces, Banach spaces, Bessel's inequality , Parseval's identity.

CO3: Learn Holder's, Minkowski's inequality for L^p , l^p spaces..

CO4: Concepts such as Bounded linear transformation, Hann Banach Theorem will be learned along with the applications

CO5: Students will learn about Open mapping, Closed graph Theorem, Uniform Boundedness Principal.

CO6:. Knowledge about Dual spaces of L^p , l^p spaces will be gained.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Baire spaces, Hilbert spaces R^n**	15
2	**Normed linear spaces**	15
3	**Bounded linear maps**	15
4	**Basic theorems**	15
	Total	**60**

PRACTICALS

Unit	Topic	No. of Hours/Credits
Module 1	Baire spaces. Open subspace of a Baire space is a Baire space. Complete metric spaces are Baire spaces and application to a sequence of continuous real valued functions converging point-wise to a limit function on a complete metric space. Hilbert spaces, examples of Hilbert spaces such as $l^2, L^2(-\pi,-\pi), L^2(\mathrm{R}^n)$ (with no proofs). Bessel's inequality. Equivalence of complete orthonormal set and maximal orthonormal basis. Orthogonal decomposition. Existence of a maximal orthonormal basis. Parseval's identity. Riesz Representation theorem for Hilbert spaces.	15
Module 2	Normed Linear spaces. Banach spaces. Quotient space of a normed linear space. l^p $(1 \le p \le \infty$ spaces are Banach spaces. $L^p(\mu)$ $(1 \le p \le \infty)$ spaces: Holder's inequality, Minkowski's inequality, $L^p(\mu)$ $(1 \le p \le \infty)$ are Banach spaces Finite dimensional normed linear spaces, Equivalent norms, Riesz Lemma and application to infinite dimensional normed linear spaces	15
Module 3	Bounded linear transformations, Equivalent characterizations. The space $B(X,Y)$. Completeness of $B(X,Y)$ when Y is complete. Hahn-Banach theorem, dual space of a normed linear space, applications of Hahn Banach theorem.	15
Module 4	Open mapping theorem, Closed graph theorem, Uniform boundedness Principle. Separable spaces, examples of separable spaces such as $l^p(1 \le p < \infty)$. If the dual space X^0 of X is separable, then X is separable. Dual spaces of $l^p(1 \le p < \infty)$, Dual of $L^p(\mu)(1 \le p < \infty)$ spaces: Riesz-Representation theorem for $L^p(\mu)(1 \le p < \infty)$ spaces	15

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SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: M.Sc. (2021-22)					**Semester: III**
Course: Partial Differential Equation					**Course Code:** PSMAMT303
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	Nil	1	5	25	75

Learning Objectives:

(1) Give the students a sufficient knowledge of fundamental principles, methods and a clear perception of immense power of mathematical ideas and tools and know how to use them by modelling, solving and interpreting.

(2) Reflecting the broad nature of the subject and developing mathematical tools for continuing further study in various fields of science.

Course Outcomes:

After completion of the course, learners would be able to:

CO7: Understand and classify first and second order PDEs

CO8: Solve first order order PDE using method of characteristics

CO9: Conceive the concept of operator involved in various types of second order PDE

CO10: Find solution to heat, wave and Laplace equation using separation of variables

CO11: Understand properties of Laplace, Heat and Wave operator.

CO12: Use the properties of operators to identify the nature of solution of the given PDE in higher dimension

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	Classification of second order Linear partial differential equations	15
2	Laplace operator	15
3	Heat operator	15
4	Wave operator	15
	Total	**60**

PRACTICALS

Unit	**Topic**	**No. of Hours/Credits**
Module 1	**1.** Review of the theory of first order partial differential equations. **2.** Method of Characteristics for Quasilinear First Order Partial Differential Equations, The general Cauchy problem. **3.** Cauchy-Kowalevsky theorem, Local solvability: the Lewy example. The classification of second order linear partial differential equations.	**15**
Module 2	**1.** Symmetry properties of the Laplacian, basic properties of the Harmonic functions, the Fundamental solution, the Dirichlet and Neumann boundary value problems, Green's function. **2.** Applications to the Dirichlet problem in a ball in Rn and in a half space of Rn. Maximum Principle for bounded domains in Rn and uniqueness theorem for the Dirichlet boundary value problem.	**15**
Module 3	**1.** The properties of the Gaussian kernel, solution of initial value problem $ut - \Delta u = 0$ for $x \in Rn$& $t > 0$ and $u(x,0) = f(x)(x \in Rn)$. **2.** Maximum principle for the heat equation and applications.	**15**
Module 4	1. Wave operator in dimensions 1, 2 & 3; Cauchy problem for the wave equation. D'Alembert's solution. 2. Poisson formula of spherical means, Hadamard's method of descent, Inhomogeneous Wave equation.	15

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SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: M.Sc .(2021-22)					**Semester: III**
Course: NUMERICAL ANALYSIS					**Course Code: PSMAMT304**
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	NIL	1	5	25	75

Learning Objectives:

(1) Give the students a sufficient knowledge of fundamental principles, methods and a clear perception of immense power of mathematical ideas and tools and know how to use them by modelling, solving and interpreting.

(2) build the bridge between logical ability and applied techniques to further bring interest in coding

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Represent various number systems and the operations defined on it which enable students to apply the logic in computer systems (Application)

CO2: study and analyze the permissible error while performing iterative techniques to solve mathematical problems (Analysis)

CO3: Solve the algebraic and transcendental equations and get the approximate solution with better accuracy_(Evaluation)

CO4: Employ different methods of constructing a polynomial using Lagrange's Interpolation method (Application)

CO5: Compare the rate of convergence of different numerical formula to study its efficiency to tackle the problem(Understanding)

CO6: apply appropriate method to find area under the curve using the rules of numerical integration to predict the solution with better accuracy (Application)

Outline of Syllabus: (per session plan)

Module	Description	No of Hours
1	Basics of Numerical Analysis	15
2	Numerical linear algebra	15
3	Roots of equations	15
4	Numerical Integration	15
	Total	**60**
PRACTICALS		

Unit	Topic	No. of Hours/ Credits
Module 1	Representation of numbers: Binary system, Hexadecimal system, octal system. Ones complement, twos complement in binary application for subtraction. Russian Peasants method for multiplication and its application in binary system for multiplication. Errors in numerical computation of numbers: Floating point representation of numbers, rounding off errors and Mantissa & exponent, Truncation errors, Inherent errors. Stability, Difference between stability and convergence in numerical methods. Numerically unstable methods, ill conditioned problems and illustrations of the concepts by examples. Errors in series approximation.	**15**
Module 2	Gauss elimination to obtain LU factorization of matrices and partial pivoting in matrices. Gauss-Jacobi and Gauss-Siedel methods for solving system of linear equations with derivation of convergence.Power and inverse method,Jacobi method for symmetric matrix Greschgorin theorem and Brower's theorem for bounds of eigenvalues of matrices.	**15**
Module 3	Bisection method with proof of convergence and derivation of and rate of convergence, Regula Falsi and secant methods, Newton-Raphson method. Rates of convergence, sufficient condition for convergence of iteration scheme and application to Newton-Raphson method. Ramanujan's method, Muller's method for detection of complex roots, Berge-Vieta for roots of polynomials.	**15**
Module 4	Lagrange's interpolation formula, uniqueness of interpolation, general error in interpolation (No other interpolation formulae expected). Trapezoidal and Simpson's -rule in composite forms, Gauss Legendre numerical integration, GaussChebeschev numerical integration, Gauss-Hermite numerical integration, Gauss-Laguree numerical integration with the derivation of all methods using the method of undetermined coefficients. Estimation of error in numerical integration by using using error constant method as in [1]. Only the following seven methods are expected using C and C++ Programs: 1) Bisection method 2) NewtonRaphson method 3) Gauss-Jacobi method 4) Gauss-Siedel method 5) Trapezoidal rule 6) Simpson's rule 7) Power method.	**15**

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Suggested Readings

1. M.K Jain, S.R.K. Iyengar and R.K. Jain, Numerical methods for Scientists and Engineers, New Age International, Fifth Edition or next editions.
2. S.S.Sastry, Numerical Methods, Prentice-Hall India.9
3. V. Rajaraman, Computer Oriented Numerical Methods, Prentice Hall India.
4. H.M. Antia, Numerical Analysis , Hindustan Publications.

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program M.Sc (2021-22)	**Semester:III**
Course: Graph Theory	**Course Code: PSMAMT 405**

Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	Nil	Nil	4	25	75

Learning Objectives:

Student will be able to learn

1. Definition of different graphs
2. Properties of Euler graphs

3 Different types of Hamiltonian graphs

4 Ramsey Numbers

Course Outcomes:

After completion of the course, learners would be able t

CO1:Understand the basic definitions to write the proofs of simple theorems

CO 2: Employ the definitions to write the proofs of simple theorems

CO3: Relate real life situations with mathematical graphs

CO 4 : Develop the ability to solve problems in graph theory Problems

CO 5: Analyze real life problems using graph theory both quantitatively and qualitatively

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Connectivity**	15
2	**Trees**	15
3	**Eulerian and Hamiltonian Graphs**	15
4	**Matching and Ramsey Theory**	15
	Total	60

Unit	**Topic**	**No. of Hours/ Credits**
Module 1	**Overview of Graph theory-Definition of basic concepts such as Graph, Subgraphs, Adjacency and incidence matrix, Degree, Connected graph, Components, Isomorphism, Bipartite graphs etc., Shortest path problem-Dijkstra's algorithm, Vertex and Edge connectivity-Result κ ≤ κ0 ≤ δ, Blocks, Block-cut point theorem, Construction of reliable communication network, Menger's theorem**	**15**
Module 2	**Trees-Cut vertices, Cut edges, Bond, Characterizations of Trees, Spanning trees, Fundamental cycles, Vector space associated with graph, Cayley's formula, Connector problem- Kruskal's algorithm, Proof of correctness, Binary and rooted trees, Huffman coding, Searching algorithmsBFS and DFS algorithms**	**15**
Module 3	**Eulerian Graphs- Characterization of Eulerian Graph, Randomly Eulerian graphs, Chinese postman problem- Fleury's algorithm with proof of correctness. Hamiltonian graphs- Necessary condition, Dirac's theorem, Hamiltonian closure of a graph, Chvatal theorem, Degree majorisation, Maximum edges in a non-hamiltonian graph, Traveling salesman problem.**	**15**
Module 4	Matchings-augmenting path, Berge theorem, Matching in bipartite graph, Halls theorem, Konig's theorem, Tutte's theorem, Personal assignment problem, Independent sets and covering- α+β = p, Gallai's theorem, Ramsey theorem-Existence of r(k,l), Upper bounds of r(k,l), Lower bound for r(k,l) ≥ 2m/2 where m = min{k,l}, Generalize Ramsey numbers-r(k1,k2,··,kn), Graph Ramsey theorem, Evaluation of r(G,H) when for simple graphs G = P3,H = C4.	15

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

Suggested Readings

1. J.A. Bondy and U.S.R. Murty, Graph Theory with Applications, Elsevier.
2. J. A. Bondy and U.S. R. Murty, Graph Theory, GTM 244 Springer, 2008.
3. M. Behzad and A. Chartrand, Introduction to the Theory of Graphs, Allyn and Becon Inc., Boston, 1971.
4. K. Rosen, Discrete Mathematics and its Applications, Tata-McGraw Hill, 2011.
5. D.B.West, Introduction to Graph Theory, PHI, 2009.

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

DEPARTMENT OF MATHEMATICS

M.Sc. SEMESTER IV

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: M.Sc . (2021-22)	**Semester: IV**
Course: FIELD THEORY	**Course Code: PSMAMT401**

Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	NIL	1	5	25	75

Learning Objectives:

(1) Give the students a sufficient knowledge of fundamental principles, methods and a clear perception of immense power of mathematical ideas and tools and know how to use them by modelling, solving and interpreting.

(2) Reflecting the broad nature of the subject and developing mathematical ideas for continuing further study in various fields of science.

Course Outcomes:

After completion of the course, learners would be able to:

CO13: get the knowledge of constructible numbers and its criterion and properties(Understanding)

CO14: relate between two algebraic structures field extension and vectorspace over the field F(Analysis)

CO15: gain the knowledge of finite ,separable extension and normal extension, algebraic extension and its properties(Understanding)

CO16: Understand Galois extension and hence further evaluation of fixed field , Galois group of automorphism specifically for finite field extension(Evaluation)

CO17: obtain introduction to some properties of infinite field extension which provides different approach to study finite field extension (Analysis)

CO18: understand how to obtain splitting field of the algebraic polynomial (Evaluation)_

CO19: understand properties of solvability by radicals of polynomial which provides the student numerical tool to study pure theory.(Application).

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	Algebraic Extensions	15
2	Normal and Separable Extensions	15
3	Galois theorems	15
4	Applications	15
	Total	**60**

PRACTICALS	

Unit	**Topic**	**No. of Hours/Credits**
Module 1	)Revision: Prime subfield of a field, definition of field extension K/F, algebraic elements, minimal polynomial of an algebraic element, extension of a field obtained by adjoining one algebraic element. Algebraic extensions, Finite extensions, degree of an algebraic element, degree of a field extension. If α is algebraic over the filed F and mα(x) is the minimum polynomial of α over F, then F(α) is isomorphic to F[X]/(mα(x)). If F ⊆ K ⊆ L are fields, then [L : F] = [L : K][K : F]. If K/F is a field extension, then the collection of all elements of K which are algebraic over F is a subfield of K. If L/K , K/F are algebraic extensions, then so is L/F. Composite field K1K2 of two subfields of a field and examples. (Ref: D.S. Dummit and R.M. Foote, Abstract Algebra) Classical Straight-edge and Compass constructions: definition of Constructible points, lines, circles by Straight-edge and Compass starting with (0,0) and (1,0), definition of constructible real numbers. If a ∈ R is constructible, then a is an algebraic number and its degree over Q is a power of 2. cos20◦ is not a constructible number. The regular 7-gon is not constructible. The regular 17-gon is constructible. The Constructible numbers form a subfield of R. If a > 0 is constructible, then so is $\sqrt{a}$ (Ref: M. Artin, Algebra, Prentice Hall of India) Impossibility of the classical Greek problems: 1) Doubling a Cube, 2) Trisecting an Angle, 3) Squaring the Circle . (Ref: D.S. Dummit and R.M. Foote, Abstract Algebra)	**15**
Module 2	Splitting field for a set of polynomials, normal extension, examples such of splitting fields of xp−2 (p prime), uniqueness of splitting fields, existence and uniqueness of finite fields. Algebraic closure of a field, existence of algebraic closure. Separable elements, Separable extensions. In characteristic 0, all extensions are separable. Frobenius automorphism of a finite field. Every irreducible polynomial over a finite field is separable. Primitive element theorem. Reference for Unit II: D.S. Dummit and R.M. Foote, Abstract Algebra	**15**
Module 3	Galois group G(K/F) of a field extension K/F, Galois extensions, Subgroups, Fixed fields, Galois correspondence, Fundamental theorem of Galois theory.	**15**

Module 4	Cyclotomic field Q(ζn) (splitting field of xn − 1 over Q), cyclotomic polynomial, degree of Cyclotomic field Q(ζn). D.S. Dummit and R.M. Foote, Abstract Algebra) Galois group for an irreducible cubic polynomial, Galois group for an irreducible quartic polynomial. (Ref: M. Artin, Algebra, Prentice Hall of India) Solvability by radicals in terms of Galois group and Abel'stheorem on the insolvability of a general quintic. (Ref: D.S. Dummit and R.M. Foote, Abstract Algebra)	15

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Suggested Readings

1. D.S. Dummit and R.M. Foote, Abstract Algebra)
2. M. Artin, Algebra

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: M.Sc . (2021-22)					**Semester: IV**
Course: FOURIER ANALYSIS					**Course Code: PSMAMT402**
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	NIL	1	5	25	75

Learning Objectives:

(1) Give the students a sufficient knowledge of fundamental principles, methods and a clear perception of immense power of mathematical ideas and tools and know how to use them by modelling, solving and interpreting.

(2) Reflecting the broad nature of the subject and developing mathematical tools for continuing further study in various fields of science.

Course Outcomes:

After completion of the course, learners would be able to:

CO20: Gain the knowledge of good kernel ,Periodic function , Fejer's Kernel ,Fejer's theorem (Understanding)

CO21: Understand Parseval's identity , Convergence of L^2-periodic function, Riesz-Fischer Theorem. (Understanding)

CO22: explain Heat Equation, Laplacian , Harmonic function. Poisson Kernel, Weierstrass Approximation Theorem as application , Solution of Dirichlet problem for unit disc. Knowledge of Convergence of series. (Application)

CO23: derive fourier series expansion of periodic function with period 2pie_(Evaluation)

CO24: distinguish between even and odd function and anlyse the solution from its Fourier series (Analysis)

CO25: explain Dirichlet's Theorem on point-wise convergence of Fourier series (understanding)

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	Fourier series	15
2	Dirichlet's theorem	15
3	. Fejer's Theorem and applications	15
4	Dirichlet Problem in the unit disc	15
	Total	**60**
PRACTICALS		

Unit	**Topic**	**No. of Hours/ Credits**
Module 1	The Fourier series of a periodic function, Dirichlet kernel, Bessel's inequality for a 2π-periodic Riemann Lesbegue integrable function, convergence theorem for the Fourier series of a 2π-periodic and piecewise C 1- function, uniqueness theorem (If f, g are 2π-periodic and piecewise smooth function having same Fourier coefficients, then f = g). Relating Fourier coefficients of f and f 0 where f is continuous 2π-periodic and piecewise C 1function and a convergence theorem: If f is continuous 2π-periodic and piecewise C 1-function, then the Fourier series of f converges to f absolutely and uniformly on R.	**15**
Module 2	Review: Lebesgue measure of R, Lebesgue integrable functions, Dominated Convergence theorem, Bounded linear maps (no questions be asked). Definition of Lebesgue integrable periodic functions (i.e. L1-periodic), Fourier Coefficients of L1-periodic functions, L2-periodic functions. Any L2-periodic function is L1-periodic. Riemann Lebesgue Lemma (if f is Lebesgue integrable periodic function, then lim f ˆ (n) = 0). The |n|−→∞ Converse of Riemann-Lebesgue lemma does not hold (ref: W. Rudin, Real and Complex Analysis, Tata McGraw Hill). Bessel's inequality for a L2-periodic function.12 Dirichlet's Theorem on point-wise convergence of Fourier series (If f is Lebesgue integrable periodic function that is differentiable at a point x0, then the Fourier series of f at x0 converges to f(x0)) and convergence of the Fourier series of functions such as f(x) = |x| on [−π,π].	**15**
Module 3	Fejer's Kernel, Fejer's Theorem for a continuous 2π-periodic function, density of trigonometric polynomials in L2(−π,π), Parseval's identity. Convergence of Fourier series of an L2-periodic function w.r.t the L2-norm, Riesz-Fischer theorem on Unitary isomorphism from L2(−π,π) onto the sequence space l 2 of square summable complex sequences.	**15**
Module 4	Laplacian, Harmonic functions, Dirichlet Problem for the unit disc, The Poisson kernel, Abel summability, Abel summability of periodic continuous functions, Weierstrass Approximation Theorem as application, Solution of Dirichlet problem for the disc. Applications of Fourier series to Isoperimetric inequality in the plane and Heat equation on the circle	15

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Suggested Readings

1. W. Rudin, Real and Complex Analysis, Tata McGraw Hill
2. E. M. Stein and R. Shakarchi, Fourier Analysis an Introduction, Princeton University Press, 2003.
3. R. Beals, Analysis An Introduction, Cambridge University

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: M.Sc . (2021-22)					**Semester: IV**
Course: Differential Geometry					**Course Code: PSMAMT 403**
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	0	1	5	25	75

Learning Objectives:

(1) Give the students a sufficient knowledge of fundamental principles of Differential Geometry
(2) Reflecting the broad nature of the subject and developing mathematical tools for continuing further study in various fields of science.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Students will learn about Orthogonal tranformations , Isometries in R^n.

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C02: Knowledge about regular curves, Serret -Ferret equations will be gained.

CO3: Learn about Regular curve in R^3 , Surface as level sets, Surface of revolution, Orientable surfaces. Mobius band.

CO4: The First, Second Fundamental form, Meusnier's Theorem will be learned by students.

CO5: Students will be able to evaluate Arc length, torsion, Signed curvaatures of different regular curves .

CO6: Computation of Normal curvature. Gaussian curvature and mean curvature will be learned

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Isometries of** R^n	15
2	**Curves**	15
3	**Regular Surfaces**	15
4	**Curvature**	15
	Total	**60**
PRACTICALS		

Unit	**Topic**	**No. of Hours/Credits**
Module 1	Orthogonal transformations of R^n and Orthogonal matrices. Any isometry of R^n fixing the origin is an orthogonal transformation. Any isometry of R^n is the composition of an orthogonal transformation and a translation. Orientation preserving isometries of R^n. Reflection map about a hyperplane W of R^n through the origin:Let$W$ be a vector subspace of R^n of dimension $n - 1$. Let n be any unit vector in R^n orthogonal to W. Define T(v) = 2<v,n> n, (v ∈ R^n). Then T is an orthogonal transformation of R^n, and T is independent of the choice of n. Any isometry of R^n is the composition of at most n + 1 many reflections. Isometries of the plane: Rotation map of R^2 about any point p of R^2, reflection map of R^2 about any line l of R^2. Glide reflection of R^2 (obtained by reflecting about a line l and then translating by a non-zero vector v parallel to l). Any isometry of R^2 is a rotation, a reflection, a glide reflection, or the identity	**15**
Module 2	Regular curves in R^2 and R^3, Arc length parametrization, Signed curvature for plane curves, Curvature and torsion of curves in R^3 and their invariance under orientation preserving isometries of R^3. Serret Frenet equations. Fundamental theorem for space curves in R^3.	**15**
Module 3	Regular surfaces in R^3, Examples. Surfaces as level sets, Surfaces as graphs, Surfaces of revolution. Tangent space to a surface at a point, Equivalent definitions. Smooth functions on a surface, Differential of a smooth function defined on a surface. Orientable surfaces. Mobius band is not orientable.	**15**
Module 4	The first fundamental form. The Gauss map, the shape operator of a surface at a point, selfadjointness of the shape operator, the second fundamental form, Principle curvatures and directions, Euler's formula, Meusnier's Theorem, Normal curvature. Gaussian curvature and mean curvature, Computation of Gaussian curvature, Isometries of surfaces, Covariant differentiation, Gauss's Theorema Egragium (statement only), Geodesics.	**15**

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: M.Sc . (2021-22)					**Semester: IV**
Course: LINEAR PROGRAMMING AND OPTIMIZATION					**Course Code: PSMAMT404**
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	NIL	1	5	25	75

Learning Objectives:

(1) Give the students a sufficient knowledge of fundamental principles, methods and a clear perception of immense power of mathematical ideas and tools and know how to use them by modelling, solving and interpreting.

(2) Reflecting the broad nature of the subject and developing mathematical tools for continuing further study in various fields of science.

Course Outcomes:

After completion of the course, learners would be able to:

CO26: Gain the knowledge of local and global optima.(Understanding)

CO27: know how to find the derivative of function from IR^n to IR^m.(Evaluation)

CO28: Explain One –Dimensional Search Methods of optimization .(Analysis).

CO29: Knowledge about equality and inequality constraints, Lagrane Multiplier Theorem , KKT Theorem. (Understanding).

CO30: Knowledge about Tangent and Normal Space . (Understanding).

CO31: construct the mathematical model for any real life problem to optimize the solution_using simplex method tool.(Analysis)

CO32: find the optimal solution for any real life based transportation problem_using numerical technique(Application)

CO33: solve assignment problem which helps student to simplify real life problems like job allocation model ,marriage problem. .(Evaluation)

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	Linear Programming	15
2	Transportation Problems	15
3	Unconstrained Optimization	15
4	Constrained Optimization Problems	15
	Total	**60**

PRACTICALS	

Unit	**Topic**	**No. of Hours/Credits**
Module 1	Operations research and its scope, Necessity of operations research in industry, Linear programming problems, Convex sets, Simplex method, Theory of simplex method, Duality theory and sensitivity analysis, Dual simplex method.	15
Module 2	Transportation and Assignment problems of linear programming, Sequencing theory and Travelling salesperson problem	15
Module 3	First and second order conditions for local optima, One-Dimensional Search Methods: Golden Section Search, Fibonacci Search, Newtons Method, Secant Method, Gradient Methods, Steepest Descent Methods.	15
Module 4	Problems with equality constraints, Tangent and normal spaces, Lagrange Multiplier Theorem, Second order conditions for equality constraints problems, Problems with inequality constraints, Karush-KuhnTucker Theorem, Second order necessary conditions for inequality constraint problems.	15

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

Suggested Readings

1. H.A. Taha, Operations Research-An introduction, Macmillan Publishing Co. Inc., NY.
2. K. Swarup, P. K. Gupta and Man Mohan, Operations Research, S. Chand and sons, New Delhi.
3. S.S. Rao, Optimization Theory and Applications, Wiley Eastern Ltd, NewDelhi.
4. G. Hadley, Linear Programming, Narosa Publishing House, 1995.
5. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research (Sixth Edition), McGraw Hill
6. Chong and Zak, Introduction to Optimization, Wiley-Interscience, 1996. 7. Rangarajan and K. Sundaram, A First Course in Optimization Theory, Cambridge University Press