Rayat Shikshan Sanstha's

Karmaveer Bhaurao Patil College Vashi, Navi Mumbai

Autonomous College

[University of Mumbai]

Syllabus for Approval

CLASS	SEM	CORE COURSES - CC (12)	Ability Enhancement Compulsory Courses - AECC (2)	Skill Enhancement Courses - SEC (4)	Discipline Specific Elective - DSE (4)
FYBSc	I	Maths - 1 :Calculus-I (2+1)	EVS / CS	.....	.....
		Maths - 2 : Algebra-I(2+1)	Audit Course		
	II	Maths-1 :Calculus-II (2+1)	CS / EVS	.....	.....
		Maths-2 : Algebra-II(2+1)	Audit Course		
SYBSc	III	Maths-3: Multivariable Calculus-I (2+1)	.....	Maths_SEC-1: Foundation of Mathematics	.....
		Maths-4: Abstract Algebra-I (2+1)			
		Maths-5: Ordinary Differential Equation (2+1)			
	IV	Maths-6: Integral Calculus (2+1)	.....	Maths_SEC- 2: Discrete Mathematics	.....
		Maths-7: Linear Algebra-I (2+1)			
		Maths-8: Partial Differential Equation (2+1)			

Sr. No.	Heading	Particulars
1	Title of Course	S.Y.B.Sc. Mathematics
2	Eligibility for Admission	F.Y.B.Sc. (with Mathematics as one of the subject)
3	Passing Marks	40%
4	Ordinances/Regulations (if any)	
5	No. of Years/Semesters	One year/Two semester
6	Level	U.G.
7	Pattern	Semester
8	Status	New
9	To be implemented from Academic year	2021-2022

Date: _____

Signature: _____

Name of BOS Chairman: _____

AC- 19/04/2022

Item No: 5.10

Rayat Shikshan Sanstha's
KARMAVEER BHAURAO PATIL COLLEGE, VASHI.
NAVI MUMBAI
Sector-15- A, Vashi, Navi Mumbai - 400 703

(AUTONOMOUS COLLEGE)

Syllabus for Mathematics

Program: B.Sc.

Course: S.Y.B.Sc. Mathematics

(Choice Based Credit System with effect from

the academic year 2021-2022)

Preamble of the Syllabus:

Bachelor of Science (B.Sc.) in Mathematics is a under graduation programme of Department of Mathematics, Karmaveer Bhaurao Patil College Vashi, Navi Mumbai [Autonomous College]

The Choice Based Credit and Grading System to be implemented through this curriculum would allow students to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities. The students pursuing this course would have to develop understanding of various aspects of the mathematics. The conceptual understanding, development of experimental skills, developing the aptitude for academic and professional skills, acquiring basic concepts and understanding of hyphenated techniques are among such important aspects.

Rayat Shikshan Sanstha's
KARMAVEER BHAURAO PATIL COLLEGE, VASHI.
NAVI MUMBAI
(Autonomous)
Department of Mathematics
B. Sc. Mathematics

Program Outcomes (POs)

Learners are able to–

PO-1	**Disciplinary Knowledge**	Understand the basic concepts, fundamental principles, theoretical formulations, and experimental findings, and the scientific theories related to Physics, Chemistry, Mathematics, Microbiology, Computer Science, Biotechnology, Information Technology and its other fields related to the program.
PO-2	**Communication Skills**	Develop various communication skills such as reading, listening, and speaking skills to express ideas and views clearly and effectively.
PO-3	**Critical Thinking**	Propose novel ideas in explaining the scientific data, facts and figures related to science and technology.
PO-4	**Analytical Reasoning and Problem Solving**	Hypothesize, analyze, formulate and interpret the data systematically and solve theoretical and numerical problems in the diverse areas of science and technology.
PO-5	**Sense of Inquiry**	Curiously ask relevant questions for a better understanding of fundamental concepts and principles, scientific theories and applications related to the study.
PO-6	**Use of Modern Tools**	Operate modern tools, equipments, instruments and laboratory techniques to perform the experiments and write the programs in different languages (software).
PO-7	**Research Skills**	Understand to design, collect, analyze, interpret and evaluate information/data that is relevant to science and technology.
PO-8	**Application of Knowledge**	Develop scientific outlook and apply the knowledge with respect to subject.
PO-9	**Ethical Awareness**	Imbibe ethical, moral and social values and exercise it in day to day life.
PO-10	**Teamwork**	Work collectively and participate to take initiative for various field-based situations related to science, technology and society at large.
PO-11	**Environment and Sustainability**	Create social awareness about environment and develop sustainability for betterment of future.
PO-12	**Lifelong Learning**	Ability of self-driven to explore, learn and gain knowledge and new skills to improve the quality of life and sense of self-worth by paying attention to the ideas and goals throughout the life.

Program Specific Outcomes(PSO)

PSO-1	Recalling the concepts of mathematics and applying them to the various courses like algebra, analysis, Differential equations, statistics, etc to form mathematical models.
PSO-2	To apply knowledge of Mathematics for pursuing higher studies at reputed national and international institutes including higher research.
PSO-3	Apply Mathematics to interdisciplinary ways like statistician, mathematical finance, industry expertise and interpret quantitative ideas.

Rayat Shikshan Sanstha's

KARMAVEER BHAURAO PATIL COLLEGE, VASHI.
NAVI MUMBAI (Autonomous)
(w.e.f. the academic year 2021-22)

Semester-II

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit Scheme			
		Lecture	Practical	Tutorial	CIE	Sem End-Exam	Term work	Practical		Total	Lecture	Practical	Tutorial	Total
UGMT301	Multivariable Calculus-I	02	01	-	40	60	-	50*	-	150	02	01	-	03
UGMT302	Abstract Algebra-I	02	01	-	40	60	-	50*	-	150	02	01	-	03
UGMT303	Ordinary Differential Equation	02	01	-	40	60	-	50*	-	150	02	01	-	03
UGMTSEC304	Foundation of Mathematics	04	-	-	40	60	-	-	-	100	04	-	-	04
UGMTP303*	Practical Exam based on UGMT301, UGMT302 & UGMT303													
	Total	**10**	**03**	**-**	**160**	**240**	**-**	**150**	**-**	**550**	**10**	**03**	**-**	**13**
										Total Credit	**10**	**03**	**-**	**13**

Semester-IV

UGMT401	Integral Calculus	02	01	-	40	60	-	50*	-	150	02	1	-	03
UGMT402	Linear Algebra-I	02	01	-	40	60	-	50*	-	150	02	1	-	03
UGMT403	Partial Differential Equation	02	01	-	40	60	-	50*	-	150	02	1	-	03
UGMTSEC404	Discrete Mathematics	04	-	-	40	60	-	-	-	100	04	-	-	04
UGMTP404*	Practical Exam based on UGMT401, UGMT402 & UGMT403													
	Total	**10**	**03**	**-**	**160**	**240**	**-**	**150**	**-**	**550**	**10**	**03**	**-**	**13**
										Total Credit	**10**	**03**	**-**	**13**

Syllabus of CBCS CURRICULUM

COURSE STRUCTURE FOR SYBSC MATHEMATICS

SEMESTER III

	Course Code	Unit	Topic	Credit	L/W
CORE COURSES	**Multivariable Calculus-I**				
	UGMT301	I	Functions of several variables	3	3
		II	Differentiation		
		III	Applications		
	Abstract Algebra-I				
	UGMT302	I	Subgroups and Lagrange's Theorem	3	3
		II	Cyclic groups and cyclic subgroups		
		III	Group Isomorphism		
	Ordinary Differential Equation				
	UGMT303	I	First order First-degree Differential equations	3	3
		II	Second order Linear Differential equations		
		III	Linear System of ODEs		
SKILL ENHANCEMENT COURSE(SEC)	**Foundation of Mathematics**				
	UGMT304	I	Logic	4	4
		II	Set Theory		
		III	Properties of Sets		

SEMESTER IV

	Course Code	Unit	Topic	Credit	L/W
CORE COURSES	**Integral Calculus-I**				
	UGMT401	I	Riemann Integration	3	3
		II	Indefinite and improper integrals		
		III	Applications		
	Linear Algebra-I				
	UGMT402	I	Vector spaces	3	3
		II	Linear Transformations		
		III	Inner Product Spaces		
	Partial Differential Equation				
	UGMT403	I	First order Partial Differentiation	3	3
		II	Higher order Partial Differential Equation		
		III	Applications of Partial Differential Equation		
SKILL ENHANCEMENT COURSE(SEC)	**Discrete Mathematics**				
	UGMT404	I	Permutations and Recurrence relation	4	4
		II	Preliminary Counting		
		III	Advanced Counting		

Note: **1.** Blue Highlighted Topic / Course has focused on employability/ entrepreneurship/skill development

2. Yellow Highlighted Topic / Course is related to professional ethics, gender, human values, Environment & sustainability.

3. Green Highlighted Topic / Course is related to local/national/regional & global development needs.

SEMESTER III
UGMT301: Multivariable Calculus-I

Unit I: Functions of several variables

(Review of Vector product, Matrices, and determinants, Vectors in plane and space.) Higher-dimensional Euclidean space The Euclidean inner product on Rn and Euclidean norm function on Rn, the distance between two points, open ball in R^n, the definition of an open subset of R^n; the neighborhood of a point in Rn; sequences in R^n, the convergence of sequences- these concepts should be specifically discussed for n = 3. Functions from (scalar fields) and from (vector fields), limits and continuity of functions, algebra of limits and continuity of functions (basic results on limits and continuity of sum, difference, scalar multiples of vector fields, continuity and components of a vector field. Directional derivatives and partial derivatives of scalar fields. Mean value theorem for derivatives of scalar fields.

Unit II : Differentiation

Differentiability of a scalar field at a point of (in terms of linear transformation) and on an open subset of; the total derivative, uniqueness of total derivative of a differentiable function at a point, simple examples of finding the total derivative of functions such as, differentiability at a point of a function f implies continuity and existence of directional derivatives of f at the point, the existence of continuous partial derivatives in a neighborhood of a point implies differentiability at the point. Chain rule for scalar fields. Higher-order partial derivatives, mixed partial derivatives, sufficient condition for equality of mixed partial derivative. Euler's theorem on homogeneous function.

Unit III : Applications

Second-order Taylor's formula for scalar fields. Differentiability of vector fields, definition of differentiability of a vector field at a point, Jacobian matrix, and differentiability of a vector field at a point implies continuity. The chain rule for derivative of vector fields (statements only). Mean value inequality. Gradient of a scalar field, geometric properties of gradient, tangent and normal to the surface, Divergent and curl of vector field. Hessian matrix, Maxima, minima and saddle points. Second derivative test for extrema of functions of two variables. Method of Lagrange Multipliers.

Recommended Text Books:

1. T. Apostol, Calculus, Vol. 2, John Wiley.
2. J. Stewart, Calculus, Brooke/ Cole Publishing Co.

Additional Reference Books:

1. G.B. Thoman and R. L. Finney, Calculus and Analytic Geometry, Ninth Edition, Addison- Wesley, 1998.
2. Sudhir R. Ghorpade and Balmohan V. Limaye, A Course in Multivariable Calculus and Analysis, Springer International Edition.
3. Howard Anton, Calculus- A new Horizon, Sixth Edition, John Wiley and Sons Inc, 1999.

UGMT301 Multivariable Calculus-I

Course Outcomes: After successful completion of this course, students will be able to:

CO-1: Understand Euclidean inner product on R^n
CO-2: Distinguish limit and continuity of one variable and severable functions
CO-3: State scalar field and vector fields and apply to find gradient, divergence and curl
CO-4: Find derivative and partial derivative of functions apply on Eulers theorem
CO-5: Apply derivative for Taylors Theorem, Jacobians, maxima and minima and Method of Lagrange Multipliers

ICT Tools Used: Videos, PPT, Pen-Tablet, Scilab for graph plotting	
Students Centric Methods: Problem Solving and Participative (Experimental, Participative, Problem Solving)	
Links: SWAYAM / MOOCS: 1) https://nptel.ac.in/courses/111107108 2) https://nptel.ac.in/courses/111104125 3) https://www.khanacademy.org/math/multivariable-calculus	

The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	-	-	-	-	-	-	-	-
CO2	2	2	1	2	-	-	-	-	-	-	-	-
CO3	2	1	2	1	-	-	-	-	-	-	-	-
CO4	3	-	-	2	1	-	-	-	-	-	-	-
CO5	-	-	1	1	-	-	-	1	-	-	-	-

UGMT302: Abstract Algebra I

Unit I: Subgroups and Lagrange's Theorem (15 Lectures):

Subgroup: Definition, necessary and sufficient condition for a non-empty set to be a Subgroup. The center Z(G) of a group is a subgroup. The intersection of two (or a family of) subgroups is a subgroup. Union of two subgroups is not a subgroup in general. Union of two subgroups is a subgroup if and only if one is contained in the other. If H and K are subgroups of a group G then HK is a subgroup of G if and only if HK = KH.

Definition of Coset and properties such as:

1. If H is a subgroup of a group G and x 2 G then
2. $xH = H$ if and only if x ∈H.
3. $Hx = H$ if and only if x ∈H
4. If H is a subgroup of a group G and x; y ∈ G then
5. $xH = yH$ if and only if $x^{-1}y \in H$
6. $Hx = Hy$ if and only if $xy^{-1} \in H$

Lagrange's theorem and consequences such as Fermat's Little Theorem, Euler's theorem and if a group G has no nontrivial subgroups then the order of G is a prime and G is Cyclic.

Unit II: Cyclic groups and cyclic subgroups (15 Lectures):

Cyclic subgroup of a group, cyclic groups, (examples including$Z$; Z_n and μ_n). Properties such as:

1. Every cyclic group is abelian.
2. Finite cyclic groups, infinite cyclic groups and their generators.
3. A finite cyclic group has a unique subgroup for each divisor of the order of the group.
4. Subgroup of a cyclic group is cyclic.
5. In a finite group G; G =< a > if and only if o(G) = o(a).
6. If G =< a > and o(a) = n then G =< a^m> if and only if (n, m) = 1.
7. If G is a cyclic group of order p^n and H < G; K < G then prove that either H⊆K or K ⊆H.

Unit III: Group Isomorphism (15 Lectures):

Group homomorphisms and isomorphisms, automorphisms, Definition: Kernel and image of a group homomorphism. Examples including inner automorphisms.

Properties such as:

1) $f : G \to G'$ is a group homomorphism then $ker\ f \leq G$.
2) $f : G \to G'$ is a group homomorphism then $ker\ f = \{e\}$ if and only if f is one one.
3) $f : G \to G'$ is a group homomorphism then
   - G is abelian if and only if G' is abelian.
   - G is cyclic if and only if G' is cyclic.

Recommended Books:

1. J.B. Fraleigh, A first course in Abstract Algebra, Third edition, Narosa, New Delhi.
2. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, Second edition.
3. Bist and Sahai, algebra, Narosa Publication.
4. P.B. Bhattacharya, S.K. Jain, S. Nagpaul. Abstract Algebra, Second edition, Foundation Books, New Delhi, 1995.

Additional Reference Books:

1. T. W. Hungerford. Algebra, Springer.
2. D. Dummit, R. Foote. Abstract Algebra, John Wiley & Sons, Inc.
3. I.S. Luther, I.B.S. Passi. Algebra. Vol. I and II.
4. M. Artin, Algebra, Prentice Hall of India, New Delhi.
5. J. Gallian. Contemporary Abstract Algebra. Narosa, New Delhi.
6. Combinatroial Techniques by Sharad S. Sane, Hindustan Book Agency.

UGMT302: Abstract Algebra I

Course Outcomes: After successful completion of this course, students will be able to:

CO-1: Analyze properties implied by the definitions of subgroup cyclic group, homomorphism, isomorphism and automorphism.

CO-2: Find order of a subgroup using Lagrange's Theorem.

CO-3: Use the concepts of isomorphism and homomorphism of groups to recognize the structures groups

CO-4: Demonstrate ability to think critically by recognizing types of abelian, non-abelian and cyclic groups.

ICT Tools Used: Videos, PPT, Pen-Tablet

Students Centric Methods: Problem Solving and Participative (Experimental, Participative, Problem Solving)

Links: SWAYAM / MOOCS:

1) https://nptel.ac.in/courses/111106113
2) https://nptel.ac.in/courses/111105112
3) https://nptel.ac.in/courses/106104149

The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	--	2	1	--	--	--	1	--	--	--	--
CO2	1	--	--	2	--	--	--	--	--	--	--	--
CO3	--	--	2	1	--	--	--	--	--	--	--	--
CO4	--	--	3	1	--	--	--	--	--	--	--	--

UGMT303: ORDINARY DIFFERENTIAL EQUATIONS

Unit I: First order First-degree Differential equations (15 Lectures)

Definition of a differential equation, order, degree, ordinary differential equation and partial differential equation, linear and non linear ODE. Existence and Uniqueness Theorem for the solution of a second order initial value problem (statement only), Definition of Lipschitz function, Examples based on verifying the conditions of existence and uniqueness theorem. Review of Solution of homogeneous and non-homogeneous differential equations of first order and first degree. Notion of partial derivatives. Exact Equations: General solution of Exact equations of first order and first degree. Necessary and sufficient condition for $Mdx + Ndy = 0$ to be exact. Non-exact equations: Rules for finding integrating factors for non exact equations.

Linear and reducible linear equations of first order, finding solutions of first order differential equations of the type for applications to orthogonal trajectories, population growth, and finding the current at a given time.

Unit II: Second order Linear Differential equations (15 Lectures)

Homogeneous and non-homogeneous second order linear differentiable equations: The space of solutions of the homogeneous equation as a vector space. Wronskian and linear independence of the solutions. The general solution of homogeneous differential equations. The general solution of a non-homogeneous second order equation. Complementary functions and particular integrals. The homogeneous equation with constant coefficients. Auxiliary equation. The general solution corresponding to real and distinct roots, real and equal roots and complex roots of the auxiliary equation. Non-homogeneous equations: The method of undetermined coefficients. The method of variation of parameters.

Unit III: Linear System of ODEs (15 Lectures)

Existence and uniqueness theorems to be stated clearly when needed in the sequel. Study of homogeneous linear system of ODEs in two variables.

The Wronskian W (t) of two solutions of a homogeneous linear system of ODEs in two variables, Explicit solutions of Homogeneous linear systems with constant coefficients in two variables, examples. System of non-homogeneous equations with constant coefficient.

Recommended Books:

1. G. F. Simmons, Differential equations with applications and historical notes, McGraw Hill.
2. E. A. Coddington, An introduction to ordinary differential equations, Dover Books.
3. G. F. Simmons and Steven krantz, Differential equations with applications and historical notes, McGraw Hill.
4. Dennis Zill First course in Differential equations and its applications.

UGMT303: Ordinary differential equations

Course Outcomes: After successful completion of this course, students will be able to:

CO-1: Classify the Ordinary differential equations with respect to their order and linearity.

CO-2: Identify different types of differential equations and solve those using appropriate methods.

CO-3: Find the general solution of a homogeneous and non-homogeneous second-order ordinary differential equation.

CO-4: Construct differential equation of problem and solve by using appropriate method.

CO-5: Define a system of differential equations and solve the system.

ICT Tools Used: Videos, PPT, Pen-Tablet, Scilab for graph plotting

Students Centric Methods: Problem Solving and Participative
(Experimental, Participative, Problem Solving)

Links: SWAYAM / MOOCS:

1) https://nptel.ac.in/courses/111108081
2) https://nptel.ac.in/courses/111107111
3) https://nptel.ac.in/courses/111106100

The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	2	-	-	-	-	-	-	-	-
CO2	1	-	-	2	2	-	-	-	-	-	-	-
CO3	2	-	-	3	-	-	-	-	-	-	-	-
CO4	3	1	1	2	1	-	1	3	-	-	-	-
CO5	1	-	1	3	2	-	-	-	-	-	-	-

Skill Enhancement Course
UGMTSEC304: Foundation of Mathematics

Unit I: Logic: Introduction, propositions, truth table, negation, conjunction, and disjunction. Implications, biconditional propositions, converse, contrapositive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables, and Negations.

Unit II: Set Theory: Sets, subsets, Set operations, the laws of set theory, and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. The empty set, properties of an empty set. Standard set operations. Classes of sets. The power set of a set.

Unit III: Properties of Sets: Difference and Symmetric difference of two sets. Set identities, Generalized union, and intersections. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with an example of congruence modulo relation.

Recommended Books:

1. R.P. Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998.
2. Ajit Kumar, S. Kumaresan and B. K. Sarma, Foundation Course in Mathematics, Narosa.
3. Robert R. Stoll: Set theory and logic, Freeman & Co.
4. P.R. Halmos, Naive Set Theory, Springer, 1974.
5. Kenneth Rosen: Discrete Mathematics and its applications, Tata McGraw Hills.
6. Larry J. Gerstein: Introduction to mathematical structures and proofs, Springer.
7. Robert Wolf: Proof, logic and conjecture, the mathematician's toolbox, W. H. Freemon.
8. E. Kamke, Theory of Sets, Dover Publishers, 1950.

Course Outcomes: After successful completion of this course, students will be able to:

CO1: Properly use the vocabulary and symbolic notation of higher mathematics in definitions, theorems, and problems.

CO2: Explain the different methods for representing the relationship between sets.

CO3: Construct truth tables, prove or disprove a hypothesis, and evaluate the truth of a statement using the principles of logic.

CO4: Analyze the logical structure of statements symbolically, including the proper use of logical connectives, predicates, and quantifiers.

CO5-: Write proofs using the concepts of set theory, including the methods of Venn diagrams and truth tables, using the basic definitions and the fundamental properties of subsets and operations.

ICT Tools Used: Videos, PPT, Pen-Tablet

Students Centric Methods: Problem Solving and Participative
(Experimental, Participative, Problem Solving)

Links: SWAYAM / MOOCS:

1) https://nptel.ac.in/courses/106103205
2) https://nptel.ac.in/courses/111107058

The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	1	1	-	-	-	-	-	-	-
CO2	2	2	-	2	-	-	-	-	-	-	-	-
CO3	2	1	2	1	-	-	-	-	-	-	-	-
CO4	2	2	-	2	-	-	-	-	-	-	-	-
CO5	1	1	1	1	1	-	-	-	-	-	-	-

UGMTP303: Practical

Suggested Practical for UGMT301

1. Sequences in R^2 and R^3, limits and continuity of scalar fields and vector fields, using the definition and otherwise, iterated limits.
2. Partial derivatives and Differentiation of f(x,y), gradient.
3. Euler's theorems, Total derivative, level sets, and tangent planes, Computing directional derivatives,
4. Chain rule, higher order derivatives and mixed partial derivatives of scalar fields.
5. Taylor's formula, differentiation of a vector field at a point, finding Hessian/Jacobean matrix, Mean Value Inequality.
6. Finding maxima, minima and saddle points, second derivative test for extrema of functions of two variables and method of Lagrange multipliers.
7. Miscellaneous Theoretical Questions based on full paper

Suggested Practical for UGMT302

1. Subgroup.
2. Cosets and applications of Lagrange's theorem.
3. Applications of Fermat's little theorem.

4. Applications of Euler's theorem.
5. Cyclic group.
6. Cyclic subgroups.
7. Group Homomorphism.
8. Group Isomorphism.
9. Automorphism.
10. Miscellaneous Theoretical Questions based on full paper

Suggested Practical for UGMT 303

1. Solving exact and non exact equations.
2. Linear and reducible to linear equations, applications to orthogonal trajectories, population growth, and finding the current at a given time.
3. Finding general solution of homogeneous and non-homogeneous equations, use of known solutions to find the general solution of homogeneous equations.
4. Solving equations using method of undetermined coefficients and method of variation of parameters.
5. Solving second order linear ODEs
6. Solving a system of first order linear ODES.
7. Miscellaneous Theoretical questions from all units.

SEMESTER IV

UGMT401: Integral Calculus

Unit I: Riemann Integration

Approximation of area, Upper/Lower Riemann sums and properties, Upper/Lower integrals, Definition of Riemann integral on a closed and bounded interval, Criterion of Riemann integrability, Additivity of Riemann integral, Algebra of Riemann integrable functions, like sum, product, modulus, Riemann integrability of monotone and continuous functions.

Unit II : Indefinite and improper integrals

Fundamental theorem of integral calculus, Mean Value theorem, Integration by parts, Leibnitz rule, Differentiation under integral sign (DUIS), Improper integrals-type 1 and type 2, Absolute convergence of improper integrals, Comparison tests, Abel's and Dirichlet's tests.

Unit III : Applications

Beta and gamma functions and their properties, the relationship between beta and gamma functions. Applications of definite Integrals: Area between curves, finding volumes by slicing, volumes of solids of revolution-Disks and Washers, Cylindrical Shells, Rectification of Curves: Lengths of plane curves,

Areas of surfaces of revolution.

Recommended Books:

1. Calculus Thomas Finney, ninth edition section 5.1, 5.2, 5.3, 5.4, 5.5, 5.6.
2. R. R. Goldberg, Methods of Real Analysis, Oxford and IBH, 1964.
3. Ajit Kumar, S. Kumaresan, A Basic Course in Real Analysis, CRC Press, 2014.
4. T. Apostol, Calculus Vol.2, John Wiley
5. K. Stewart, Calculus, Booke/Cole Publishing Co, 1994.
6. J. E. Marsden, A.J. Tromba and A. Weinstein, Basic multivariable calculus.
7. Bartle and Sherbet, Real analysis.

UGMT401: Integral Calculus

Course Outcomes: After successful completion of this course, students will be able to:

CO1: Define Upper and Lower sum, Improper Integrals, beta and Gamma functions
CO2: Solves problems on Riemann integration, Improper Integrations and beta and Gamma functions
CO3: Apply the concept of Riemann Integration to prove algebra and properties
CO4: Test for convergency of improper integrals
CO5: Solve problems on rectification of curves, area and volume of revolution

ICT Tools Used: Videos, PPT, Pen-Tablet, Geogebra,

Students Centric Methods: Problem Solving and Participative
(Experimental, Participative, Problem Solving)

Links: SWAYAM / MOOCS:
1) https://nptel.ac.in/courses/111105122
2) https://www.digimat.in/nptel/courses/video/111105122/L10.html

The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	--	--	1	-	-	-	-	-	-	-
CO2	2	--	1	2	-	-	-	-	-	-	-	-
CO3	1	1	2	-	-	-	-	-	-	-	-	-
CO4	2	2	-	2	-	-	-	-	-	-	-	-
CO5	2	-	2	2	1	1	-	1	-	-	-	-

UGMT402: LINEAR ALGEBRA-I

Unit I: Vector spaces (15 Lectures)

Definition of vector space, examples with real entries space of real valued functions on a non empty set Subspace: Definition, examples of subspaces such as lines, plane passing through origin upper triangular, lower triangular, diagonal, symmetric and skew-symmetric matrices as subspaces solutions of m homogeneous linear equations in n unknowns as a subspace; space of continuous real valued functions on a nonempty set properties of subspace such as necessary and sufficient condition for a non empty subset to be a subspace of a vector space, arbitrary intersection of subspaces of a vector space is a subspace; union of two subspaces is a subspace if and only if one is a subset of the other, Linear combinations of vectors in a vector space.

Linear span of a non empty subset N of a vector space, N is the generating set of linear span of a non empty subset of a vector space is a subspace of the vector space, Linearly independent / Linearly dependent sets in a vector space, properties Basis of a vector space, Dimension of a vector space, maximal linearly independent subset of a vector space is a basis of a vector space, minimal generating set of a vector space is a basis of a vector space, any two basis of a vector space have the same number of elements, Quotient space.

Unit II: Linear Transformations: (15 lectures)

Linear transformations: Definition, examples, one one and onto linear transformation, Kernel and image of a linear transformation, Rank-Nullity theorem, Linear isomorphism, inverse of a linear isomorphism, Any n-dimensional real vector space is isomorphic to R^n. Matrix representation of a linear transformation, Equivalence of rank of an m× n matrix A and rank of the linear transformation L_A: $R^n \rightarrow R^m$ ($L_A(X) = AX$).

Unit III: Inner Product Spaces (15 Lectures)

Dot product in R^n; Definition of general inner product on a vector space over R. Examples of inner product including the inner product $\langle f, g\rangle = \int_{-\pi}^{\pi} f(t)g(t)dt$ on $C[-\pi, \pi]$ the space of continuous real valued functions on $[-\pi, \pi]$ Norm of a vector in an inner product space. Cauchy-Schwarz inequality, Triangle inequality, Orthogonality of vectors, Pythagoras theorem and geometric applications inR^2, Projections on a line, The projection being the closest approximation, Orthogonal complements of a subspace, Orthogonal complements in $R^2$and R^3. Orthogonal sets and orthonormal sets in an inner product space, Orthogonal and orthonormal bases. Gram-Schmidt orthogonalisation process, Simple examples in R^3, R^4.

Recommended book:

1. S Kumaresan, Linear Algebra, A Geometric approach, PHI Learning Private limited, Delhi.

Additional Reference Book:

1. Kenneth Hoffman & Ray Kunze, Linear Algebra, Pearson Publication.
2. Steven H Friedberg, Insel, Spence, Linear Algebra, Pearson Education India.
3. L. Smith: Linear Algebra, Springer Verlag.
4. David C Lay, Linear Algebra and its applications, Pearson Education India.

UGMT402: Linear Algebra-I

Course Outcomes: After successful completion of this course, students will be able to:

CO1: Apply the subspace test to find whether a given set is a subspace of the vector space.
CO2: Determine whether a set is linearly dependent or linearly independent.
CO3: Define linear transformations, kernel, and image of a linear transformation.
CO4: Define dot product, inner product, and general inner product space.
CO5: Find the orthonormal basis of a vector space using the Gram-Schmidt orthogonalization process.

ICT Tools Used: Videos, PPT, Pen-Tablet, GeoGebra.

Students Centric Methods: Problem Solving and Participative
(Experimental, Participative, Problem Solving)

Links: SWAYAM / MOOCS:

1) https://nptel.ac.in/courses/111108098
2) https://nptel.ac.in/courses/111106051
3) https://nptel.ac.in/courses/111102011

The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	3	-	1	3	1	-	-	3	-	-	-	-
CO2	1	-	1	2	1	-	-	-	-	-	-	-
CO3	2	1	-	-	-	-	-	-	-	-	-	-
CO4	3	1	-	-	-	-	-	-	-	-	-	-
CO5	1	-	2	3	1	-	1	1	-	-	-	-

UGMT403: Partial Differential Equation

Course Outcomes:

1. Understand difference between Ordinary and partial differential Equation
2. To formation of partial differential equation (by eliminating constant and function)
3. To find solution of first and higher order partial differential equation
4. Analyse types of Partial differential Equation
5. Apply Partial differential Equation to wave and heat equation.

Unit 1: First order Partial Differentiation

Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations (eliminating arbitrary constant and function), Solution of Linear partial differential equation of first order, Lagrange's method, method of multipliers, Integral surface of the linear PDE, Non-linear partial differential equation in p and q, Charpit's method.

Unit 2: Higher order Partial Differential Equation

Linear Partial differential equation of n^{th} order with constant coefficients, Rules for Complimentary Function and rules to find Particular integrals (general methods and short methos), non-Homogeneous linear equation, Monge's method (Nonlinear equation of second order).

Unit 3: Applications of Partial Differential Equation

Classification of second order partial differential equations into elliptic, parabolic and hyperbolic through (illustrations only), Applications by using method of separation of Variables, to solve vibrating string and heat equation.

Books Recommended

1. Shepley L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, 1984.
2. I. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, International Edition, 1967.
3. Introduction of Partial Differential Equations, Third Edition. K. Sunkara Rao, PHI Learning Private Limited, New Delhi.
4. Advanced Engineering Mathematics Erwin kreyszig
5. Schaum's Outline of Partial Differential Equations (Schaum's)
6. W. E. Williams, "Partial Differential Equations", Claredon Press Oxford

UGMT403: Partial Differential Equation

Course Outcomes: After successful completion of this course, students will be able to:
CO1: Understand difference between Ordinary and partial differential Equation
CO2: Form partial differential equation (by eliminating constant and function)
CO3: Find solution of first and higher order partial differential equation
CO4: Analyse types of Partial differential Equation

CO5: Apply Partial differential Equation to wave and heat equation.
ICT Tools Used: Videos, PPT, Pen-Tablet, Matlab
Students Centric Methods: Problem Solving and Participative (Experimental, Participative, Problem Solving)
Links: SWAYAM / MOOCS: 1) https://onlinecourses.swayam2.ac.in/cec20_ma08/preview 2) https://nptel.ac.in/courses/111107111 (Unit 7,8 & 9) 3) https://nptel.ac.in/courses/111103021
The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	--	--	--	-	-	-	-	-	-	-
CO2	2	--	1	1	-	-	-	-	-	-	-	-
CO3	2	1	1	2	-	-	-	-	-	-	-	-
CO4	2	1	-	1	-	-	-	-	-	-	-	-
CO5	2	-	2	2	-	-	-	-	-	-	-	-

Skill Enhancement Course
UGMTSEC404: Discrete Mathematics

After successful completion of the course students will be

1. Understand the basic concepts of Mathematical reasoning and basic counting techniques, relations and proofs.
2. Use recursion formulae and counting principles for preliminary counting.
3. Use iterative methods for solving homogeneous and non-homogeneous recurrence relations.
4. Apply the concepts of divide and conquer method and principle of inclusion and exclusion to solve some simple algorithms in discrete mathematics
5. Apply various properties and principles for advanced counting.

Unit I: Permutations and Recurrence relation (15 lectures)

Permutation of objects, S_n, the composition of permutations, results such as every permutation is a product of disjoint cycles, every cycle is a product of transpositions, even and odd permutation, rank, and signature of a permutation, the cardinality of S_n, A_n.

Recurrence Relations, the definition of non-homogeneous, linear, non-linear recurrence relation, obtaining recurrence relation in counting problems, solving homogeneous as well as non-homogeneous recurrence relations by using iterative methods, solving a homogeneous recurrence relation of second degree using algebraic method proving the necessary result.

Unit II: Preliminary Counting (15 Lectures)

Finite and infinite sets, countable and uncountable sets examples such as $N, Z, N \times N, Q, (0,1), R$.

Addition and multiplication Principle, counting sets of pairs, two ways counting. Stirling numbers of second kind. Simple recursion formulae satisfied by S(n, k) for k = 1, 2,…, n – 1, n

Pigeonhole principle and its strong form, its application.

Unit III: Advanced Counting (15 Lectures)

Binomial and Multinomial Theorem, Pascal identity, examples of standard identities such as the following with emphasis on combinatorial proofs.

$\sum_{k=0}^{r} (m\,k)(n\,r-k) = (m+n\,r)$ $\quad\quad$ $\sum_{i=r}^{n} (i\,r) = (n+1\,r+1)$

$\sum_{i=0}^{k} (k\,i)^2 = (2k\,k)$ $\quad\quad$ $\sum_{i=0}^{n} (n\,i) = 2^n$

Permutation and combination of sets and multi-sets, circular permutations, emphasis on solving problems.
Non-negative and positive solutions of equation $x_1 + x_2 + \ldots + x_k = n$
Principal of inclusion and exclusion, its applications, derangements, explicit formula for d_n, deriving formula for Euler's function $\varphi(n)$.

Recommended Books:

1. Norman Biggs: Discrete Mathematics, Oxford University Press.
2. Richard Brualdi: Introductory Combinatorics, John Wiley and sons.
3. V. Krishnamurthy: Combinatorics-Theory and Applications, Affiliated East West Press.
4. Discrete Mathematics and its Applications, Tata McGraw Hills.
5. Schaum's outline series: Discrete mathematics,
6. Applied Combinatorics: Allen Tucker, John Wiley and Sons.

Skill Enhancement Course
UGMTSEC402: Discrete Mathematics

Course Outcomes: After successful completion of the course students will be

CO1. Understand the basic concepts of Mathematical reasoning and basic counting techniques, relations and Proofs.

C02. Use recursion formulae and counting principles for preliminary counting.

C03. Use iterative methods for solving homogeneous and non-homogeneous recurrence relations.

C04. Apply the concepts of divide and conquer method and principle of inclusion and exclusion to solve some simple algorithms in discrete mathematics

C05. Apply various properties and principles for advanced counting.

ICT Tools Used: Videos, PPT, Pen-Tablet

Students Centric Methods: Problem Solving and Participative
(Experimental, Participative, Problem Solving)

Links: SWAYAM / MOOCS:

1. Discrete Mathematics - Course (nptel.ac.in)
2. https://archive.nptel.ac.in/courses/106/106/106106183/

The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	1	-	-	-	-	-	-	-	-
CO2	2	2	1		-	-	-	-	-	-	-	-
CO3	1	2	-	1	-	-	-	-	-	-	-	-
CO4	2	2	-	2	-	-	-	-	-	-	-	-
CO5	1	1	-	2	1	-	-	-	-	-	-	-

UGMTP404: Practical.

Suggested Practical for UGMT401:

1. Calculation of upper sum, lower sum and Riemann integral
2. Problems on properties of Riemann integral.
3. Problems on fundamental theorem of calculus, mean value theorems, integration by parts, Leibnitz rule.
4. Convergence of improper integrals, applications of comparison tests, Abel's and Dirichlet's tests, and functions.
5. Beta Gamma Functions
6. Problems on rectification of curves, area, volume, length.
7. Miscellaneous Theoretical Questions based on full paper.

Suggested Practical for UGMT402

1) Vector Spaces.
2) Subspaces
3) Matrix of linear transformations.
4) Linear Span and Properties of vector Spaces.
5) Rank-Nullity theorem.
6) System of linear equations.
7) Determinants, calculating determinants of 2×2 matrices, n $\times$n diagonal, upper triangular matrices using definition and Laplace expansion.
8) Inner product spaces, examples. Orthogonal complements in R^2andR^3.
9) Gram-Schmidt method.
10) Miscellaneous Theoretical Questions based on full paper

Suggested Practical for UGMT403:

1. Formation of first order partial differential equations (eliminating arbitrary constant and function)
2. Solution of Linear partial differential equation
3. Solution of Linear second and higher order partial differential equation
4. Non-Homogeneous linear equation, Monge's method (Nonlinear equation of second order).
5. Classification of PDE, Applications by using method of separation of Variables
6. Problems on vibrating string and heat equation.
7. Miscellaneous Theoretical questions from all units.

Scheme of Examination

Class: S.Y.B.Sc.

I. Semester End Examinations: There will be a Semester-end Theory examination of 60 marks for each of the courses UGMT301, UGMT302, UGMT303 of Semester III and UGMT401, UGMT402, UGMT403 of semester IV to be conducted by the college.

1. Duration: The examinations shall be of 2 Hours duration.

2. Theory Question Paper Pattern:

a) There shall be **FOUR** questions. The questions first three questions shall be of **15 marks** each based on the units I, II, III respectively. The **fourth** question shall be of **15 marks** based on the entire syllabus.

b) All the questions shall be compulsory. The questions shall have internal choices within. Including the choices, the marks for each question shall be 30.

c) The questions may be subdivided into sub-questions and the allocation of marks depends on the weightage of the topic.

II. Continuous Internal Assessment:

There will be internal evaluation of 40 marks.

Paper	20 Marks	10 Marks	10 Marks
Paper I	Unit Test	Assignment	Group Project (Max. 10 people) Content 5 marks, Viva 5 marks **OR** Online Course (Individual) Certificate 7 marks, Viva 3 marks
Paper II	Unit Test	Assignment	
Paper III	Unit Test	Assignment	

Question paper pattern for Unit Test of 20 marks:

The unit test for 20 marks will be conducted online. There shall be 20 compulsory multiple choice questions with single correct answer, each carrying one mark.

III. Semester End Examinations Practical:

At the end of the Semesters III and IV, Practical examinations of three hours duration and 150 marks shall be conducted for the courses **UGMTP303**, **UGMTP404**.

In semester III, the Practical examinations for **UGMT301** and **UGMT302** are held together and the Practical examination for **UGMT303** is held separately

In semester IV, the Practical examinations for **UGMT401** and **UGMT402** are held together and the Practical examination for **UGMT403** is held separately.

Paper pattern: The question paper shall have three parts A, B, C.

Each part shall have two Sections.

Section I Objective in nature: Attempt any Eight out of Twelve multiple choice questions.

(8×3 = 24 Marks)

Section II Problems: Attempt any Two out of Three. (8×2 = 16 Marks)

Practical Course	**Part A**	**Part B**	**Part C**	**Marks out of**	**Duration**
UGMTP303	Questions from UGMT301	Questions from UGMT302	Questions from UGMT303	120	3 hours
UGMTP404	Questions from UGMT401	Questions from UGMT402	Questions from UGMT403	120	3 hours

Marks for Journals and Viva:

For each course UGMT301, UGMT302, UGMT303, UGMT401, UGMT402 and UGMT403:

1. Journals: 5 marks.
2. Viva: 5 marks.

Each Practical of every course of Semester III and IV shall contain 10 (ten) problems out of which minimum 05 (five) have to be written in the journal. A student must have a certified journal before appearing for the practical examination.