SWAMI VIVEKANAND SUBHARTI UNIVERSITY
UGC Approved
Meerut

ACCREDITED WITH GRADE A NAAC

Ordinance No. :- V-126-B-44

(Approved in Academic council meeting held on 11.03.2026
Proposed to be ratified in forthcoming executive council)

Evaluation Scheme and Syllabus

of

B.Sc. Mathematics

FOUR – YEAR UNDER GRADUATE PROGRAM

(AS PER NEP-2020)

Keral Verma Subharti College of Science

Swami Vivekanand

SUBHARTI UNIVERSITY

Meerut

Effective from 2025-2026

Head
Deptt. of Mathematics
Faculty of Science
S.V.S.U., Meerut

Programme Objectives of B.Sc. Mathematics

The **B.Sc. Mathematics programme** aims to develop students' analytical thinking, logical reasoning, and problem-solving abilities through a strong foundation in mathematical concepts and techniques. The programme prepares students to understand abstract ideas, apply mathematical tools to real-world problems, and pursue advanced studies or careers in research, education, data analysis, finance, and other technical fields. It also focuses on nurturing critical thinking, computational skills, and the ability to communicate mathematical ideas effectively. Overall, the programme equips learners with the knowledge, skills, and attitude required to become competent professionals and lifelong learners in the field of mathematics.

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Programme Outcome(POs):

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

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

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

PO4: Students will become employable in various govt. and private sectors

PO5: Scientific temper in general and mathematical temper in particular will be developed in students.

Programme Specific Outcomes (PSOs)

PSO1: Student should be able to possess 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 skills etc.

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

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KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

Department of Mathematics,

All UG Courses offered by Department of Mathematics,(Session 2025-26 onwards)

		I	II	III	IV	V	VI	VII	VIII	Total
1	Major	6	6	9	15	10	14	16	4	80
2	Minor	3	3	3	3	6	6	4	4	32
3	Multi Disciplinary	3	3	3						9
4	Ability Enhancement Course	2	2	2	2					8
5	Skill Enhancement Course	3	3	3						9
6	Value Added Course	3	3							6
7	Internship					4				4
8	Research								12	12
	Total	20	20	20	20	20	20	20	20	160

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Semester-wise Titles of the Major Course (MJC) Papers in B.Sc. (Research/Honors)-Mathematics

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
1	I	BSMT-101	Calculus I	Theory	06
	II	BSMT-201	Algebra-I	Theory	04
		BSMT-201P	Maths Practical	Practical	02
2	III	BSMT-301	Differential Equations	Theory	05
		BSMT-302	Calculus II	Theory	04
	IV	BSMT-401	Modern Algebra	Theory	05
		BSMT-402	Mathematical Methods	Theory	05
		BSMT-403	Mechanics	Theory	05
3	V	BSMT-501	Real Analysis-I	Theory	05
		BSMT-502	Numerical Analysis	Theory	05
		BSMT-503	Internship	Practical	04
	VI	BSMT-601	Metric Spaces	Theory	05
		BSMT-602	Linear Algebra	Theory	05
		BSMT-603	Real Analysis-II	Theory	05
4	VII	BSMT-701	Probability Theory & Statistics		05
		BSMT-702	Discrete Mathematics	Theory	05
		BSMT-703	Optimization Technique and Game Theory	Theory	04
		BSMT-705P	Mathematical Tools Practical	Practical	02
	VIII	BSMT-801	Complex Analysis	Theory	04

Semester-wise Titles of the Minor Course (MIC) Papers in B.Sc.(Research/Honors)-Mathematics

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
1	I	BSMT-102	Introduction of Set Theory	Theory	03
	II	BSMT-202	Matrices and It's Applications	Theory	03
2	III	BSMT-303	Vector Calculus	Theory	03

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	IV	BSMT-404	Graph Theory	Theory	03
3	**V**	BSMT-504	Introduction to Linear Programming	Theory	03
		BSMT-505	Introductory Probability	Theory	03
	VI	BSMT-604	Theory of Real Functions	Theory	03
		BSMT-605	Applied Statistics	Theory	03
4	**VII**	BSMT-704	Differential Geometry	Theory	04
	VIII	BSMT-802	Formal Language and Automata	Theory	04
		BSMT-803R	Research Project/ Dissertation	Practical	12

Semester-wise Titles of the Multidisciplinary Course (MDC) Papers in B.Sc.(Research/Honors)-Mathematics

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
1	**I**	M-DIS-A/B	A. Statistical Methods	Theory	03
			B. Geometry		
	II	M-DIS-A/B	A. Laplace Transform and It's Applications	Theory	03
			B. Cryptography and Network Security		
2	**III**	M-DIS-A/B	A. Linear Programming and It's Applications	Theory	03
			B. Introduction to Information Theory and Coding		

Semester-wise Titles of the Skill Enhancement Course (SEC) Papers in B.Sc.(Research/Honors)-Mathematics

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
1	**I**	SEC-A/B/C(**Any ONE**)	A. Basic Number Theory	Theory	03
			B. Bio-Mathematics		
			C. Sets and Logic		
	II	SEC-A/B/C(**Any ONE**)	A. Mathematical Finance	Theory	03
			B. Statistical Techniques for Research Methods		
			C. Introduction to tensor Calculus		
2	**III**	SEC-A/B/C(**Any ONE**)	A. Computer Algebra Systems and Related Software's	Theory	03
			B. Basic Numerical Methods		
			C. LaTeX and HTML		

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Semester-wise Titles of the Value Added Course (VAC) Papers in B.Sc.(Research/Honors)-Mathematics

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
1	I	VAC-RB	Rashtra Bodh	Theory	03
	II	VAC-IKS	Indian Knowledge System	Theory	03

Semester-wise Title sof the Ability Enhancement Course (AEC) Papers in B.Sc.(Research/Honors)-Mathematics

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
1	I	AEC-01	English Communication Skill	Theory	02
	II	AEC-02	Environmental Science	Theory	02
2	III	AEC-03	Disaster Risk Management	Theory	02
	IV	AEC-04	Course on NCC/NSS/NGO'S/SCOUT GUIDE/SPORTS	Theory	02

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KERAL VERMA SUBHARTI COLLEGE OF SCIENCE												
Department of Mathematics,												
Batch:2025 -26			**Programe Name - B.Sc.- Mathematics**					**SEMESTER - I**				
S.No.	**Course Type**	**Course Code**	**Course Name**	**Teaching Load**			**Credits**		**Internal Assessment**		**External Assessment**	**Total**
				L	**T**	**P**						
THEORY and PRACTICAL SUBJECTS								**Attendance (5)**	**quiz/PPT/Assignment (10)**	**Mid Sem Test (15)**	**End Sem Exam (70)**	
1	**MJC-1**	BSMT-101	Calculus-I	6	0	0	**6**	5	10	15	70	100
2	**MIC-1**	BSMT-102	Introduction of Set Theory	3	0	0	**3**	5	10	15	70	100
3	**MDC-1**	M-DIS-STM	A. Statistical Methods	3	0	0	**3**	5	10	15	70	100
4		M-DIS-GY	B. Geometry									
5	**SEC-1**	SEC-BNT	A. Basic Number Theory	3	0	0	**3**	5	10	15	70	100
6		SEC-AC	B. Bio-Mathematics									
7		SEC-SL	C. Sets and Logic									
8	**AEC-1**	AEC-01	English Communication Skill	2	0	0	**2**	5	10	15	70	100
9	**VAC**	VAC	Value Added Course 01	3	0	0	**3**	5	10	15	70	100
10	**VAC-1**	VAC-RB	Rasthra Bodh	2	0	0	**2**	0	0	0	50	50
TOTAL CREDITS / ASSESSMENT							**20**	**30**	**60**	**90**	**420**	**600**

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Batch:2025-26			Programe Name - B.Sc.- Mathematics					SEM:II					
S.No.	Course Type	Course Code	Course Name	Teaching Load			Credits		Internal Assessment		External Assessment	Total
				L	T	P						
THEORY and PRACTICAL SUBJECTS								Attendance (5)	quiz/PPT /Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)	
1	MJC-2	BSMT-201	Algebra-I	4	0	0	4	5	10	15	70	100
2	MJC-2P	BSMT-201P	Maths Practical	0	0	4	2	5	10	15	70	100
3	MIC-2	BSMT-202	Matrices and It's Applications	3	0	0	3	5	10	15	70	100
4	MDC-2	M-DIS- LT	A. Laplace Transform and It's Applications	3	0	0	3	5	10	15	70	100
		M-DIS- CN	B. Cryptography and Network Security									
5	SEC-2	SEC-FM	A. Financial Mathematics	3	0	0	3	5	10	15	70	100
		SEC-ST	B. Statistical Techniques for Research Methods		0							
		SEC-IT	C. Introduction to tensor Calculus		0							
6	AEC-2	AEC-02	Environmental Science	2	0	0	2	5	10	15	70	100
7	VAC	VAC-AAM	Value Added Course 02(Advanced Applied Mathematics)	3	0	0	3	5	10	15	70	100
8	VAC-2	VAC-IKS	Indian Knowledge System (IKS)	2	0	0	2	0	0	0	50	50
TOTAL CREDITS / ASSESSMENT							20	35	70	105	490	700

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Department of Mathematics (B.Sc. Research/Honors)

Semester I

Major Course I

Course Name: Calculus-I	**Course Code:** BSMT-101

Credits = L+T+P (6+1+0)	**Hours (Total) = 90**

Course Objectives: It is a basic course on the study of real valued functions that would develop an analytical ability to have a more matured perspective of the key concepts of calculus, namely, limits, continuity, differentiability and their applications.

Course Contents:

Unit 1:

Limits of functions, Sequential criterion for limits, Divergence criteria, Limit theorems, One-sided limits, Infinite limits and limits at infinity. Continuous functions, Sequential criterion for continuity and discontinuity, Algebra of continuous functions, Properties of continuous functions on closed and bounded intervals; Uniform continuity, Non-uniform continuity criteria, Uniform continuity theorem.

Unit 2:

Differentiability of functions, Successive differentiation, Leibnitz's theorem, Partial differentiation, Euler's theorem on homogeneous functions. Tangents and normals, Curvature, Asymptotes, Singular points.

Unit 3:

Differentiability of a function, Algebra of differentiable functions, Carathéodory's theorem and chain rule; Relative extrema, Interior extremum theorem, Rolle's theorem, Mean- value theorem and its applications, Intermediate value property of derivatives - Darboux's theorem.

Unit 4:

Taylor polynomial, Taylor's theorem with Lagrange form of remainder, Application of Taylor's theorem in error estimation; Relative extrema, and to establish a criterion for convexity; Taylor's series expansions of simple trigonometric and exponential functions

Course Learning Outcomes: This course will enable the students to learn:

1. To have a rigorous understanding of the concept of limit of a function.
2. The geometrical properties of continuous functions on closed and bounded intervals.
3. The applications of mean value theorem and Taylor's theorem.
4. The student is equipped with standard concepts and tools at an intermediate to advance level that will serve him well towards taking more advance level course in mathematics

Reference:

1. Bartle, Robert G., & Sherbert, Donald R. (2015). *Introduction to Real Analysis* (4th ed.). Wiley India Edition. New Delhi.

Additional Readings:

1. Ghorpade, Sudhir R. & Limaye, B. V. (2006). *A Course in Calculus and Real Analysis*. Undergraduate Texts in Mathematics, Springer (SIE). First Indian reprint.

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2. Mattuck, Arthur. (1999). *Introduction to Analysis*, Prentice Hall.

3. Ross, Kenneth A. (2013). *Elementary Analysis*: *The theory of calculus* (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian Reprint.

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Semester I

Minor Course I

Course Name: Introduction of Set Theory	**Course Code:** BSMT-102

Credits =L+T+P (3+1+0)	**Hours (Total) = 45**

Course Objectives: The course will enable the students to obtain the conceptual idea of Sets and related topics like Venn diagram, cardinality of a set etc. Idea of the relations and different types of mappings. Learn about the algebraic structure of real numbers.

Unit 1
Sets, Venn diagrams, cardinality of a set, power set, operations on sets, De Morgan's law. Normal set, abnormal set, paradox.
Relations, equivalence relations, equivalence class, partition, Fundamental theorem of equivalence relation, partial order, poset, chain with practical examples .

Unit 2
Mappings, bijective mappings, composition of mappings, inverse of a mapping.

Unit 3
Integers, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm. Prime numbers and their properties, Euclid's theorem. Congruence relation between integers. Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

Unit 4
Real Numbers: Algebraic structure of real numbers, decimal representation of real numbers, upper and lower bound, lub and glb properties, Archimedean property, density property, modulus, Intervals.
Different series of real numbers (example: Fibonacci series, and its presence in arts and nature).

Course Outcomes: This course specifically enable to the students:

1. Prime numbers and different properties along with operations of these numbers.
2. Knowing about the idea of real number series.

Reference Books :

1. I. A. Herstein, Topics in Algebra, Willey Eastern Limited, 2nd Edition, 1975
2. M. K. Sen, S. Ghosh, P. Mukhopadhyay and S. K. Maity, Topics in Abstract Algebra, Universities press, 3rd Edition, 2019
3. J. A. Gallian, Contemporary Abstract Algebra, Cengage, 9th Edition, 2017
4. T. A. Garrity, All the Math You Missed (But Need to Know for Graduate School), Cambridge University Press, 2nd Edition, 2021
5. R. K. Ghosh and K. C. Maity, An introduction to analysis: Differential Calculus (Part I), New Central Book Agency, 13th Edition, 2011
6. Shanti Narayan and M.D. Raisinghania, Elements of Real Analysis, S. Chand & Company Ltd., New Delhi, 2010.
7. B. K. Lahiri and K. C. Roy, Real Analysis, The World Press Private Ltd., 3rd Edition, 2008

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Semester I

Multidisciplinary Course (MDC)

A- Statistical Methods

OR

B- Geometry

Course Name: Statistical Methods	**Course Code:** M-DIS-SM

Credits = L+T+P (3+1+0)	**Hours (Total) =45**

UNIT I:

Introduction: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement - nominal, ordinal, interval and ratio.

Presentation: tabular and graphic, including histogram and Ogives.

Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, moments, Skewness and kurtosis.

UNIT II:

Bivariate data: Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation. Simple linear regression, principle of least squares and fitting of polynomials and exponential curves.

UNIT III:

Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability – classical, statistical, and axiomatic. Conditional Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes' theorem and its applications.

Random Variables: Discrete and continuous random variables, p.m.f., p.d.f. ,c.d.f. Illustrations of random variables and its properties. Expectation, variance, moments and moment generating function.

Standard probability distributions: Binomial, Poisson, geometric, uniform, normal and exponential,

SUGGESTED READING:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
4. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.
5. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
6. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi

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OR

Course Name: Geometry	**Course Code:** M-DIS-G

Credits = L+T+P (3+1+0)	**Hours (Total) =45**

UNIT I

General equation of second degree, System of conics, Tracing of conics, Confocal conics, Polar equation of conics and its properties.

UNIT I I

Three-Dimensional Coordinates, Projection and Direction Cosine, Plane (Cartesian and vector form), Straight line in three dimension (Cartesian and vector form).

UNIT III

Sphere, Coneand Cylinder. Central conicoids, Paraboloids, Plane section of conicoids, Generating lines, Confocal conicoids, Reduction of second degree
equations.

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Semester I

Skill Enhancement Course (SEC)-1

A-Basic Number Theory

OR

B- Bi- Mathematics

OR

C- Sets and Logic

Course Name: Basic Number Theory	**Course Code:** SEC-BNT

Credits =L+T+P (3+1+0)	**Hours (Total) =45**

Course Objectives: In number theory there are challenging open problems which are comprehensible at undergraduate level, this course is intended to build a micro aptitude of understanding aesthetic aspect of mathematical instructions and gear young minds to ponder upon such problems. Also, another objective is to make the students familiar with simple number theoretic techniques, to be used in data security.

Course Contents:

Unit 1: Distribution of Primes and Theory of Congruencies

Linear Diophantine equation, Prime counting function, Prime number theorem, Goldbach conjecture, Fermat and Mersenne primes, Congruence relation and its properties, Linear congruence and Chinese remainder theorem, Fermat's little theorem, Wilson's theorem.

Unit 2: Number Theoretic Functions

Number theoretic functions for sum and number of divisors, Multiplicative function, The Mobius inversion formula, The greatest integer function. Euler's phi-function and properties, Euler's theorem.

Unit 3: Primitive Roots

The order of an integer modulo *n*, Primitive roots for primes, Composite numbers having primitive roots; Definition of quadratic residue of an odd prime, and Euler's criterion.

Course Learning Outcomes: This course will enable the students to learn:

1. Some of the open problems related to prime numbers, viz., Goldbach conjecture etc.
2. About number theoretic functions and modular arithmetic.

References:

1. Burton, David M. (2007). *Elementary Number Theory* (7th ed.). Tata Mc-Graw Hill Edition, Indian Reprint.

2. Jones, G. A., &Jones, J. Mary. (2005). *Elementary Number Theo*ry. Undergraduate Mathematics Series (SUMS). First Indian Print.

Additional Reading:

1. Neville Robinns. (2007). *Beginning Number Theory* (2nd ed.). Narosa Publishing House Pvt. Limited, Delhi.

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OR

Course Name: Bi- Mathematics	Course Code: SEC-BM

Credits = L+T+P (3+1+0)	Hours (Total) =45

Course Objectives: The focus of the course is on scientific study of normal functions in living systems. The emphasis is on exposure to nonlinear differential equations with examples such as heartbeat, chemical reactions and nerve impulse transmission. The basic concepts of the probability to understand molecular evolution and genetics have also been applied.

Course Contents:

Unit 1: Modeling Biological Phenomenon

Population growth, Administration of drugs, differential equations, Heartbeat, Nerve impulse prey models. Cell division, Systems of linear ordinary transmission, Chemical reactions, Predator.

Unit 2: Mathematics of Heart Physiology and Nerve Impulse Transmission

Stability and oscillations**:** Epidemics, The phase plane and the Jacobian matrix, Local stability, Stability, Limit cycles, Forced oscillations; Mathematics of Heart Physiology**:** The local model, The Threshold effect, The phase plane analysis and the heartbeat model, A model of the cardiac pacemaker; Mathematics of Nerve Impulse Transmission**:** Excitability and repetitive firing, Travelling waves.

Unit 3: Bifurcation and Chaos

Bifurcation, Bifurcation of a limit cycle, Discrete bifurcation and period-doubling, Chaos, Stability of limit cycles, The Poincaré plane.

Unit 4: Modeling Molecular Evolution and Genetics

Modelling Molecular Evolution**:** Matrix models of base substitutions for DNA sequences, The Jukes-Cantor model, The Kimura models, Phylogenetic distances; Constructing Phylogenetic Trees**:** Phylogenetic trees, Unweighted pair-group method with arithmetic means (UPGMA), Neighbor joining method; Genetics**:** Mendelian genetics, Probability distributions in genetics.

Course Learning outcomes: Apropos conclusion of the course will empower the student to:

1. Learn the development, analysis and interpretation of bio mathematical models.
2. Reinforce the skills in mathematical modeling.
3. Appreciate the theory of bifurcation and chaos.
4. Learn to apply the basic concepts of probability to molecular evolution and genetics.

References:

1. Allman, Elizabeth S., & Rhodes, John A. (2004). *Mathematical Models in Biology*: *An Introduction*. Cambridge University Press.

2. Jones, D. S., Plank, M. J., & Sleeman, B. D. (2009). *Differential Equations and Mathematical Biology* (2nd ed.). CRC Press, Taylor & Francis Group, LLC.

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Additional Readings:

1. Murray, J. D. (2002). *An Introduction to Mathematical Biology* (3rd ed.). Springer.
2. Myint-U, Tyn (1977). *Ordinary Differential Equation*. Elsevier North-Holland, Inc.
3. Simmons, George F., & Krantz, Steven G. (2015). *Differential Equations*. McGraw-Hill Education. Indian Reprint.
4. Strogatz, Steven H. (2009). *Nonlinear Dynamics and Chaos* (2nd ed.). Perseus Book Publishing. LLC. Sarat Publication, Kolkata, India.

OR

Course Name: Sets and Logic	**Course Code:** SEC-SL

Credits = L+T+P (3+1+0)	**Hours (Total) = 45**

. **Course Objectives:** The student acquires the knowledge of Knowing about the concept of the Post tautology theorem. Assimilating the concept of completeness interpretations and their applications with special emphasis on applications in algebra.

UNIT I

Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Power set of a set. Difference and Symmetric difference of two sets. De Morgan's law, Set identities. Family of sets. Generalized union and intersections. Cartesian product of sets.

UNIT II

Mappings, Bijective mappings, composition of mappings, inverse of a mapping.

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UNIT III

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

Course Learning outcomes: The course will enable the students to:

1. Learn the syntax of first-order logic and semantics of first-order languages.
2. Understand the propositional logic and basic theorems like compactness theorem, meta theorem and post-tautology theorem.
3. Familiarize with syntax of propositional logic, sets and their consequences.

SUGGESTED READING:

1. R.P. Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998.
2. P.R. Halmos, Naive Set Theory, Springer, 1974.
3. E. Kamke, Theory of Sets, Dover Publishers, 1950.
4. M. K. Sen, S. Ghosh, P. Mukhopadhyay and S. K. Maity, Topics in Abstract Algebra, Universities press, 3rd Edition, 2019 .

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Semester I
Ability Enhancement Course (AEC)– I

Course Name: English Communications Skills	**Course Code: AEC-01**

Credits =L+T+P (2+0+0)	**Hours (Total) =30**

Semester I
Value Added Course-I

Course Name: Indian Knowledge System (IKS)	**Course Code:** VAC-01

Credits =L+T+P (3+1+0)	**Hours (Total) =45**

Course out comes:

By studying this course, students will be able to:

- Explain the evolution of Indian Knowledge system.
- Identify the characteristics of various era's in History of IKS.
- Identify the Nature of Indian Knowledge System.
- Enlist the key characteristics of IKS.
- Identify Key aspects of the epistemology of the Indian Knowledge System.
- Explain the knowledge framework & classification.
- List the ancient scripts of India.
- Outline the influence of ancient sacred texts on Indian Society.
- List the ancient scripts of India.
- Outline the influence of ancient sacred texts on Indian Society.

Unit-I History of Indian Knowledge System
- Genesis of Bhartiya Knowledge System
- History of IKS

Unit-II India's characteristic knowledge & India's epistemology
- IKS: Nature, Philosophy and Character
- India's Epistemology Knowledge Frameworks & Classification

Unit-III Ancient Scriptures
- Ancient Scriptures

Unit-IV Ancient Education System
- Ancient Education
- Educating Sciences

Unit-V Scientific approaches of IKS & Torch-bearers
- KhagolVijnana (Astronomy)
- Vastukala (Architecture)
- Ayurveda Krishi Vijnana (Agricultural) Practices

Unit-VI Scientific approaches of IKS & Torch-bearers
- Dhatu Vijnana (Metallurgy)
- Ganita: Mathematics in India
- Yuddha Vidhya (Military Sciences)
- Niyuddha Kala (Martial Arts)
- Environmental Sciences

Unit-VII Literary Aspects of IKS & Torch-bearers.
- Chandashastra (Prosody)
- Bhasa Va Vyakarana (Language and Grammar)

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- Bharata's Natyashastra (Science of Drama, Dance and Music)

Unit-VIII Governance in IKS & Way Forward

- Science of Consciousness in Ancient India (Cognitive Science)
- Anviksiki (Logic and Disputation)
- Governance & Public Administration
- IKS way forward

SUGGESTED READINGS:

1. Introduction to Indian Knowledge System: Concepts and Applications, Archak, K.B. (2012). Kaveri Books, New Delhi.ISBN-13:978-9391818203
2. Introduction To Indian Knowledge System: Concepts and Applications, Mahadevan, B.Bhat, Vinayak Rajat,Nagendra Pavana R.N.PHI, ISBN: 9789391818203
3. Glimpse into Kautilya's ArthashastraRamachandrudu P. (2010), Sanskrit Academy, HyderabadISBN:9788380171074
4. "Introduction" in Studies in Epics and Purāṇas, (Eds.), KM Munshi and N Chandrashekara Aiyer Bhartiya Vidya Bhavan

OR

Value Added Course-I1

Course Name: Rashtrya Bodh	**Course Code:** VAC-RB

Credits =L+T+P (3+1+0)	**Hours (Total) =45**

Course outcomes: By studying this course, students will be able to:

- explain the concept and nature of health, wellness and its various implications
- demonstrate adequate knowledge on well-being and promotion of healthy behavior

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Semester II

Major Course II

Course Name: Algebra-I	**Course Code:** BSMT-201

Credits =L+T+P (4+1+0)	**Hours (Total) =60**

Course Objectives: The primary objective of this course is to introduce the basic tools of theory of equations, complex numbers, number theory and matrices to understand their linkage to the real-world problems. Perform matrix algebra with applications to Computer Graphics.

Course Contents:

Unit 1: Theory of Equations and Complex Numbers

Elementary theorems on the roots of an equation, Polynomials, The remainder and factor theorem, Synthetic division, Factored form of a polynomial, The Fundamental theorem of algebra, Relations between the roots and the coefficients of polynomial equations, Imaginary roots occur in pairs, Integral and rational roots; Polar representation of complex numbers, The *n*th roots of unity, De Moivre's theorem for integer and rational indices and its applications.

Unit 2: Equivalence Relations and Functions

Equivalence relations, Functions, Composition of functions, Invariability and inverse of functions, One-to-one correspondence and the cardinality of a set.

Unit 3: Basic Number Theory

The division algorithm, Divisibility and the Euclidean algorithm, The fundamental theorem of arithmetic, Modular arithmetic and basic properties of congruences; Principles of mathematical induction and well ordering principle.

Unit 4: Row Echelon Form of Matrices.

Systems of linear equations, Row reduction and echelon forms, Vector equations, The matrix equation $A\mathbf{x} = b$, Solution sets of linear systems, Linear independence, The rank of a matrix and applications; Introduction to linear transformations, The matrix of a linear transformation; Matrix operations,

Unit 5: Applications of Matrices:

The inverse of a matrix, Characterizations of invertible matrices, Applications to Computer Graphics, Eigenvectors and Eigen values, The characteristic equation and the Cayley-Hamilton theorem.

Course Learning Outcomes: This course will enable the students to:

1. Employ De - Moivre's theorem in a number of applications to solve numerical problems.
2. Apply Euclid's algorithm and backwards substitution to find greatest common divisor.
3. Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank.
4. Find Eigen values and corresponding eigenvectors for a square matrix.

References:

1. Andreescu, Titu & Andrica Dorin. (2014). *Complex Numbers from A to...Z*. (2nd ed.). Birkhäuser.
2. Dickson, Leonard Eugene (1922). *First Course in The Theory of Equations*. John Wiley & Sons, Inc. New York. The Project Gutenberg EBook.

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3. Goodaire, Edgar G., & Parmenter, Michael M. (2005). *Discrete Mathematics with Graph Theory* (3rd ed.). Pearson Education Pvt. Ltd. Indian Reprint 2015.
4. Lay, David C., Lay, Steven R., & McDonald, Judi J. (2016). *Linear Algebra and its Applications* (5th ed.). Pearson Education

Additional Readings:

1. Andrilli, Stephen, & Hecker, David (2016). *Elementary Linear Algebr*a (5th ed.). Academic Press, Elsevier India Private Limited.

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Semester II

Major Course -P

Course Name: Maths Practical	**Course Code:** BSMT-201P

Credits =L+T+P (2+1+0)	**Hours (Total) =30**

Course Objectives: The primary objective of this course is to introduce the basic tools of theory of equations, complex numbers, number theory and matrices to understand their linkage to the real-world problems. Perform matrix algebra with applications to Computer Graphics.

Course Contents:

Study of museum specimens/slides:

List of the practical's to be done using R/Python /Mathematica/MATLAB/Maple/Scilab/ Maximaetc.

1. Plotting the simple polynomial graphs .
2. By plotting the graph find the solution of the equation.
3. Plotting the graphs of polynomial of degree 2,3,4and5,and their first and second derivatives.
4. Tracing of conic in Cartesian coordinates.
5. Find numbers between two real numbers and plotting of finite and infinite sub set of R.
6. Study the convergence of sequences through plotting.
7. Study the convergence/divergence of infinite series by plotting their sequences of partial sum.

Course Learning Outcomes: This course will enable the students to:

1. The main objective of the course is to equip the student to plot the different graph using different computer software such as Mathematica /MATLAB/Maple /Scilab/Maxima etc.

2. The next objective of the course is to solve the different types of equations by plotting the graph using different computer software such as Mathematica /MATLAB/Maple / Scilab/Maxima etc.

3. Student would be Solving the systems of linear equations

4. After completion of this course student would be able to know the convergence of sequences through plotting, matrix.

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Semester II

Minor Course II

Course Name: Matrices and It's Applications	**Course Code:** BSMT-202

Credits =L+T+P (3+1+0)	**Hours (Total) =45**

Course Objectives: The primary objective of this course is to introduce the basic tools of theory of matrices to understand their linkage to the real-world problems. Perform matrix algebra with applications to Computer Graphics.

Course Contents:

Unit 1: Matrices:

Matrix, Submatix, Types of matrices such as symmetric, skew symmetric, Hermitian, Skew Hermitian, Nilpotent, Involutary, Orthogonal etc., Singular and Non singular matrices, Addition and subtraction of matrices, Rank of matrices, Matrix Equation, Solution by Cramer's rule and Gauss Elimination method.

Unit 2: Row Echelon Form of Matrices:

Systems of linear equations, Row reduction and echelon forms, Vector equations, The matrix equation $A\mathbf{x} = b$, Solution sets of linear systems, Linear independence, The rank of a matrix and applications; Introduction to linear transformations, The matrix of a linear transformation; Matrix operations,

Unit 3: Applications of Matrices:

The inverse of a matrix, Characterizations of invertible matrices, Applications to Computer Graphics, Eigen vectors and Eigen values, The characteristic equation and the Cayley-Hamilton theorem.

Course Learning Outcomes: This course will enable the students to:

1. Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank.
2. Find Eigen values and corresponding eigenvectors for a square matrix.

References:

1. Andreescu, Titu & Andrica Dorin. (2014). *Complex Numbers from A to...Z*. (2nd ed.). Birkhäuser.
2. Dickson, Leonard Eugene (1922). *First Course in The Theory of Equations*. John Wiley & Sons, Inc. New York. The Project Gutenberg EBook.
3. Goodaire, Edgar G., & Parmenter, Michael M. (2005). *Discrete Mathematics with Graph Theory* (3rd ed.). Pearson Education Pvt. Ltd. Indian Reprint 2015.
4. Kolman, Bernard, & Hill, David R. (2001). *Introductory Linear Algebra with Applications* (7th ed.). Pearson Education, Delhi. First Indian Reprint 2003.
5. Lay, David C., Lay, Steven R., & McDonald, Judi J. (2016). *Linear Algebra and its Applications* (5th ed.). Pearson Education

Additional Readings:

1. Andrilli, Stephen, & Hecker, David (2016). *Elementary Linear Algebr*a (5th ed.). Academic Press, Elsevier India Private Limited.

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Semester II
Multidisciplinary Course (MDC)

A- Laplace Transform and It's Applications

OR

B- Cryptography and Network Security

Course Name: Laplace Transform and It's Applications	**Course Code:** M-DIS-LT

Credits =L+T+P (3+1+0)	**Hours (Total) =45**

Course Objectives: The course will enable the students to know about piecewise continuous functions, Dirac delta function, Laplace transforms and its properties. Solve ordinary differential equations using Laplace transforms.

Course Contents:

Unit 1
Laplace transform, Linearity, Existence theorem, Laplace transforms of derivatives and integrals, Shifting theorems, Change of scale property, Laplace transforms of periodic functions, Dirac delta function.

Unit 2
Differentiation and integration of transforms, Convolution theorem, Integral equations, Inverse Laplace transform, Lerch's theorem, Linearity property of inverse Laplace transform, Translations theorems of inverse Laplace transform, Inverse transform of derivatives,

Unit 3
Applications of Laplace transform in obtaining solutions of ordinary differential equations and integral equations.

Course Learning Outcomes: After the course, the student will be able to:

1. Fourier series, Bessel's inequality, term by term differentiation and integration of Fourier Series.
2. application of this course in real life problems.

OR

Course Name: Cryptography and Network Security	**Course Code:** M-DIS-CN

Credits =L+T+P (3+1+0)	**Hours (Total) =45**

Course Objectives: This course helps the students to develop skills and knowledge of standard concepts in cryptography and demonstrates how cryptography plays an important role in the present digital world by knowing encryption and decryption techniques and secure data in transit across data networks.

Course Contents:

Unit 1: Cryptography and Data Encryption Standard (DES)

Overview of Cryptography, Computer security concepts, Security attacks, Symmetric cipher model, Cryptanalysis and brute-force attack, Substitution techniques, Caesar cipher, Monoalphabetic ciphers, Playfair cipher, Hill cipher,

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Polyalphabetic ciphers, One-time pad, Transposition techniques, Binary and ASCII, Pseudo-random bit generation, Stream ciphers and Block ciphers, The Feistal cipher, The data encryption standard (DES), DES example.

Unit 2: Algorithms and Advanced Encryption Standard (AES)

Review of basic concepts in Number theory and Finite Fields**:** Divisibility, Polynomial and modular arithmetic, Fermat's and Euler's theorems, The Chinese remainder theorem, Discrete logarithm., Finite fields of the form GF(p) and GF(2^n). Advanced encryption standard (AES), AES transformation functions, AES key expansion, AES example.

Unit 3: Public-key Cryptography

Principles of public-key cryptosystems, The RSA algorithm and security of RSA, Elliptic curve arithmetic, Elliptic curve cryptography, Cryptographic Hash functions, Secure Hash algorithm.

Unit 4: Digital Signatures and Network Security

Digital signatures, Elgamal and Schnorr digital signature schemes, Digital signature algorithm. Wireless network and mobile device security, Email architecture, formats, threats and security, Secure/Multipurpose Internet Mail Extension (S/MIME) and Pretty Good Privacy (PGP).

Course Learning Outcomes: After the course, the student will be able to:

1. Understand the fundamentals of Cryptography and Network Security, including data and advanced encryption standard (DES & AES), RSA and elliptic curve cryptography.
2. Encrypt and decrypt messages using block ciphers, sign and verify messages using well known signature generation and verification algorithms.
3. Acquire knowledge of standard algorithms that can be used to provide confidentiality, integrity and authentication of data.

References:

1. Stallings, William (2017). *Cryptography and Network Security*, *Principles and Practice* (7th ed.). Pearson Education Limited. England.
2. Trappe, Wade & Washington, Lawrence C. (2006). *Introduction to Cryptography with Coding Theory* (2nd ed.). Pearson Education International.

Additional Reading:

1. Stinson, Douglas R. (2005). *Cryptography Theory and Practice* (3rd ed.). CRC Press.

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Semester II

Skill Enhancement Course (SEC) -I1

A- Mathematical Finance

OR

B- Statistical Techniques for Research Methods

OR

C- Introduction to tensor Calculus

Course Name: Mathematical Finance	**Course Code:** SEC-MF

Credits =L+T+P (3+1+0)	**Hours (Total) =45**

Course Objectives: This course is an introduction to the application of mathematics in financial world, that enables the student to understand some computational and quantitative techniques required for working in the financial markets and actuarial mathematics.

Course Contents:

Unit 1: Interest Rates

Interest rates, Types of rates, Measuring interest rates, Zero rates, Bond pricing, Forward rate, Duration, Convexity, Exchange traded markets and OTC markets, Derivatives--Forward contracts, Futures contract, Options, Types of traders, Hedging, Speculation, Arbitrage.

Unit 2: Mechanics and Properties of Options

No Arbitrage principle, Short selling, Forward price for an investment asset, Types of Options, Option positions, Underlying assets, Factors affecting option prices, Bounds on option prices, Put-call parity, Early exercise, Effect of dividends.

Unit 3: Stochastic Analysis of Stock Prices and Black-Scholes Model

Binomial option pricing model, Risk neutral valuation (for European and American options on assets following binomial tree model), Lognormal property of stock prices, Distribution of rate of return, expected return, Volatility, estimating volatility from historical data, Extension of risk neutral valuation to assets following GBM, Black-Scholes formula for European options.

Unit 4: Hedging Parameters, Trading Strategies and Swaps

Hedging parameters (the Greeks: Delta, Gamma, Theta, Rho and Vega), Trading strategies involving options, Swaps, Mechanics of interest rate swaps, Comparative advantage argument, Valuation of interest rate swaps, Currency swaps, Valuation of currency swaps.

Course Learning outcomes: In this course, the student will learn the basics of:

1. Financial markets and derivatives including options and futures.
2. Pricing and hedging of options, interest rate swaps and no-Arbitrage pricing concept.
3. Stochastic analysis (Ito formula and Ito integration) and the Black-Scholes model.

Reference:

1. Hull, J. C., & Basu, S. (2010). *Options, Futures and Other Derivatives* (7th ed.). Pearson Education. New Delhi.

Additional Readings:

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1. Luenberger, David G. (1998). *Investment Science*, Oxford University Press. Delhi.

2. Ross, Sheldon M. (2011). *An elementary Introduction to Mathematical Finance* (3rd ed.). Cambridge University Press. USA.

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Semester II

Course Name: Statistical Techniques for Research Methods	**Course Code:** SEC-ST

Credits=L+T+P(3+1+0)	**Hours=45**

Course Objectives: The learning objectives include. To provide scientific approaches to develop the domain of human knowledge through empirical studies. To enable the student researchers to understand basic concepts and aspects related to research, data collection, analyses and interpretation.

Course Contents:

UNIT I - Introduction: Meaning, objection and motivation in research, types of research, research approach, significance of research. Research problems: definition, selection and necessity of research problems.

UNIT II - Survey Methodology and Data Collection, inference and error in surveys, the target populations, sampling frames and coverage error, methods of data collection, non-response, questions and answers in surveys.

UNIT III - Processing, Data Analysis and Interpretation: Review of various techniques for data analysis covered in core statistics papers, techniques of interpretation, precaution in interpretation.

UNIT IV - Develop a questionnaire, collect survey data pertaining to a research problem (such as gender discriminations in private v/s government sector, unemployment rates, removal of subsidy, impact on service class v/s unorganized sectors), interpret the results and draw inferences.

Course Learning Outcomes: After completion of this course, students should have developed a clear understanding of:

- Research methodology
- Research Problem.
- Research Designs
- Comparative study of different methods of data collection
- Guidelines for construction of questionnaires
- Processing and Analysis of data
- Interpretation and Report writing

SUGGESTED READINGS:

1. Kothari, C.R. (2015). Research Methodology: Methods and Techniques, 3rd Edition reprint, New Age International Publishers.
2. Kumar, R. (2011). Research Methodology: A Step-by-Step Guide for Beginners, SAGE publications.
3. Cochran, W.G. and Cox, G.M. (1959). Experimental Design. Asia Publishing House.

OR

Semester II

Course Name: Introduction to Tensor Calculus	**Course Code:** SEC- IT

Credits = L+T+P (3+1+0)	**Hours (Total) =45**

Course Objectives: The course will enable the students to explain the basic concepts of tensors. Understand role of tensors in differential geometry.

Course Contents:

Unit1

Contra variant and covariant vectors, Transformation formulae, Tensor product of two vector spaces, Tensor of type (r, s), Symmetric and skew-symmetric properties, Contraction of tensors, Quotient law, Inner product of vectors.

Unit2

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Fundamental tensors, Associated covariant and contravariant vectors, Inclination of two vectors and orthogonal vectors, Christoffel symbols, Law of transformation of Christoffel symbols,

Unit3

Covariant derivatives of covariant and contravariant vectors, Covariant differentiation of tensors, Curvature tensor, Ricci tensor, Curvature tensor identities.

Course Learning outcomes: Apropos conclusion of the course will empower the student to:

1. understanding the role of Gauss's Theorema Egregium and its consequences.
2. application of problem-solving with differential geometry to diverse situations in physics, engineering and in other mathematical contexts.

Reference Books:

1. C. Bär, Elementary Differential Geometry. Cambridge University Press, 2010.
2. M.P. do Carmo, Differential Geometry of Curves & Surfaces, 2nd Ed., Dover Publications, 2016.
3. A. Gray, Modern Differential Geometry of Curves and Surfaces with Mathematica, 4th Ed., Chapman & Hall/CRC Press, Taylor & Francis, 2018.

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Semester II

Ability Enhancement Course (AEC)- II

Course Name: Environmental Science	**Course Code:** AEC-02

Credits =L+T+P (2+1+0)	**Hours (Total) =30**

Semester II
Value Added Course-II

Course Name: Indian Knowledge System (IKS)	**Course Code:** BVAC-02

Credits =L+T+P (3+1+0)	**Hours (Total) =45**

Course out comes:

By studying this course, students will be able to:

- Explain the evolution of Indian Knowledge system.
- Identify the characteristics of various era's in History of IKS.
- Identify the Nature of Indian Knowledge System.
- Enlist the key characteristics of IKS.
- Identify Key aspects of the epistemology of the Indian Knowledge System.
- Explain the knowledge framework & classification.
- List the ancient scripts of India.
- Outline the influence of ancient sacred texts on Indian Society.
- List the ancient scripts of India.
- Outline the influence of ancient sacred texts on Indian Society.

Unit-I History of Indian Knowledge System
- Genesis of Bhartiya Knowledge System
- History of IKS

Unit-II India's characteristic knowledge & India's epistemology
- IKS: Nature, Philosophy and Character
- India's Epistemology Knowledge Frameworks & Classification

Unit-III Ancient Scriptures
- Ancient Scriptures

Unit-IV Ancient Education System
- Ancient Education
- Educating Sciences

Unit-V Scientific approaches of IKS & Torch-bearers
- KhagolVijnana (Astronomy)
- Vastukala (Architecture)
- Ayurveda Krishi Vijnana (Agricultural) Practices

Unit-VI Scientific approaches of IKS & Torch-bearers
- Dhatu Vijnana (Metallurgy)
- Ganita: Mathematics in India
- Yuddha Vidhya (Military Sciences)
- Niyuddha Kala (Martial Arts)
- Environmental Sciences

Unit-VII Literary Aspects of IKS & Torch-bearers.
- Chandashastra (Prosody)
- Bhasa Va Vyakarana (Language and Grammar)
- Bharata's Natyashastra (Science of Drama, Dance and Music)

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Unit-VIII Governance in IKS & Way Forward

- Science of Consciousness in Ancient India (Cognitive Science)
- Anviksiki (Logic and Disputation)
- Governance & Public Administration
- IKS way forward

SUGGESTED READINGS:

1. Introduction to Indian Knowledge System: Concepts and Applications, Archak, K.B. (2012). Kaveri Books, New Delhi.ISBN-13:978-9391818203
2. Introduction To Indian Knowledge System: Concepts and Applications, Mahadevan, B.Bhat, Vinayak Rajat,Nagendra Pavana R.N.PHI, ISBN: 9789391818203
3. Glimpse into Kautilya's ArthashastraRamachandrudu P. (2010), Sanskrit Academy, HyderabadISBN:9788380171074
4. "Introduction" in Studies in Epics and Purāṇas, (Eds.), KM Munshi and N Chandrashekara Aiyer Bhartiya Vidya Bhavan

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SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT

KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

Department of Mathematics

Batch:2025 -26			Programe Name - B.Sc.- Mathematics					SEM:III						
S.No.	Course Type	Course Code	Course Name	Teaching Load			Credits		Internal Assessment			External Assessment	Total	Remark
				L	T	P								
THEORY and PRACTICAL SUBJECTS								Attendance (5)	quiz/PPT /Assignment (10)	Mid Sem Test (15)		End Sem Exam (70)		
1	MJC-3	BSMT -301	Differential Equations	5	0	0	5	5	10	15		70	100	
2	MJC-4	BSMT -302	Calculus II	4	0	0	4	5	10	15		70	100	
3	MIC-3	BSMT -303	Vector Calculus	3	0	0	3	5	10	15		70	100	
4	MDC-3	MDC-LPA	A. Linear Programming and It's Applications	3	0	0	3	5	10	15		70	100	
		MDC-IITC	B. Introduction to Information Theory and Coding											
5	SEC-3	SEC-CASRS	A. Computer Algebra Systems and Related Software's	3	0	0	3	5	10	15		70	100	
		SEC-BNM	B. Basic Numerical Methods											

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		SEC-LH	C. LaTeX and HTML										
6	**AEC-3**	AEC-03	Disaster Risk Management	2	0	0	**2**	5	10	15	70	100	
TOTAL CREDITS / ASSESSMENT							**20**	**30**	**60**	**90**	**420**	**600**	

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT

KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

Department of Mathematics,

Batch:2025 -26			**Programe Name - B.Sc.-Mathematics**					**SEM:IV**						
S.No.	**Course Type**	**Course Code**	**Course Name**	**Teaching Load**			**Credits**		**Internal Assessment**		**External Assessment**	**Total**	**Remark**
				L	**T**	**P**							
THEORY and PRACTICAL SUBJECTS								**Attendance (5)**	**quiz/PPT/ Assignment (10)**	**Mid Sem Test (15)**	**End Sem Exam (70)**		
1	**MJC-5**	BSMT-401	Modern Algebra	5	0	0	**5**	5	10	15	70	100	
2	**MJC-6**	BSMT-402	Mathematical Methods	5	0	0	**5**	5	10	15	70	100	
3	**MJC-7**	BSMT-403	Mechanics	5	0	0	**5**	5	10	15	70	100	
4	**MIC-4**	BSMT-404	Graph Theory	3	0	0	**3**	5	10	15	70	100	
5	**AEC-4**	AEC-4	Course on NCC/NSS/NGO'S/Scout Guide's/ Sports	2	0	0	**2**	5	10	15	70	100	
TOTAL CREDITS / ASSESSMENT							**20**	**25**	**50**	**75**	**350**	**500**	

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Semester III

Course Name: Differential Equations	Course Code: BSMT - 301

Credits =L+T+P (5+1+0)	Hours (Total) = 75

Course Objectives: The main objectives of this course are to introduce the students to the exciting world of Differential Equations and their applications.

Course Contents:

Unit 1:

Formation of a differential equation (D.E.), Degree, order and solution of a D.E., Equations of first order and first degree : Separation of variables method, Solution of homogeneous equations, linear equations and exact equations, Differential equations of the first order but not of the first degree, Clairaut's equations and singular solutions, Orthogonal trajectories.

Unit 2:

Linear differential equations with constant coefficients, Homogeneous linear differential equations. Simultaneous linear differential equations with constant coefficients, (including the method of variation of parameters).

Unit 3:

Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Linear partial differential equation of first order, Lagrange's method

Unit 4:

Introduction, Classification, Construction and geometrical interpretation of first order partial differential equations (PDE), Method of characteristic and general solution of first order PDE, Canonical form of first order PDE, Method of separation of variables for first order PDE.

Course Learning Outcomes: The course will enable the students to:

1. Formulate Differential Equations for various Mathematical models.
1. Solve first order non-linear differential equation and linear differential equations of higher order using various techniques.
2. Apply these techniques to solve and analyze various mathematical models.
3. Formulate, classify and transform partial differential equations.

References:

1. Barnes, Belinda & Fulford, Glenn R. (2015). *Mathematical Modelling with Case Studies, Using* Maple *and* MATLAB (3rd ed.). CRC Press, Taylor & Francis Group.
2. Edwards, C. Henry, Penney, David E., & Calvis, David T. (2015). *Differential Equation and Boundary Value Problems*: *Computing and Modeling* (5th ed.). Pearson Education.
1. Ross, Shepley L. (2004). *Differential Equations* (3rd ed.). John Wiley & Sons. India

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Semester III

Course Name: Calculus II	**Course Code: BSMT 302**

Credits = L+T+P (4+1+0)	**Hours (Total) = 60**

Course Objectives: The primary objective of this course is to introduce the basic tools of calculus and geometric properties of different conic sections which are helpful in understanding their applications in planetary motion, design of telescope and to the real-world problems. Also, to carry out the hand on sessions in computer lab to have a deep conceptual understanding of the above tools to widen the horizon of students' self-experience.

Course Contents:

Unit 1: Derivatives for Graphing and Applications

The first-derivative test for relative extrema, Concavity and inflection points, Second-derivative test for relative extrema, Curve sketching using first and second derivative tests; Limits to infinity and infinite limits, Graphs with asymptotes, L'Hôspital's rule; Applications in Business, Economics and Life Sciences; Higher order derivatives, Leibniz rule.

Unit 2: Sketching and Tracing of Curves

Parametric representation of curves and tracing of parametric curves (except lines in R^3), Polar coordinates and tracing of curves in polar coordinates; Techniques of sketching conics, Reflection properties of conics, Rotation of axes and second degree equations, Classification into conics using the discriminate.

Unit 3: Volume and Area of Surfaces

Volumes by slicing disks and method of washers, Volumes by cylindrical shells, Arc length, Arc length of parametric curves, Area of surface of revolution; Hyperbolic functions; Reduction formulae.

Unit 4: Vector Calculus and its Applications

Introduction to vector functions and their graphs, Operations with vector functions, Limits and continuity of vector functions, Differentiation and integration of vector functions; Modeling ballistics and planetary motion, Kepler's second law; Unit tangent, Normal and binormal vectors, Curvature.

Course Learning Outcomes: This course will enable the students to:

1. Sketch curves in a plane using its mathematical properties in the different coordinate systems of reference.
2. Apply derivatives in Optimization, Social sciences, Physics and Life sciences etc.
3. Compute area of surfaces of revolution and the volume of solids by integrating over cross-sectional areas.
4. Application o0f vector calculus in different field of science.

References:

1. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). *Calculus* (10th ed.). John Wiley & Sons Singapore Pte. Ltd. Indian Reprint (2016) by Wiley India Pvt. Ltd. Delhi.

2. Osborne, George. A. (1906). *Differential and Integral Calculus with Examples and Applications*. Revised Edition. D. C. Health & Co. Publishers. Boston, U.S.A.

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3. Strauss, Monty J., Bradley, Gerald L., & Smith, Karl J. (2007). *Calculus* (3rd ed.). Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). Delhi. Indian Reprint 2011.

Additional Reading:

1. Thomas, Jr. George B., Weir, Maurice D., & Hass, Joel (2014). *Thomas*' *Calculus* (13th ed.). Pearson Education, Delhi. Indian Reprint 2017.

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Semester III

Minor Course III

Course Name: Vector Calculus	**Course Code:** BSMT 303

Credits =L+T+P (3+1+0)	**Hours (Total) = 45**

Course Objectives: The main objective of this course is to give a deep insight of the differentiations and its consequence applications and techniques of sketching for curves in Cartesian and polar coordinate systems.

UNIT I

Product of three or more vectors, Applications in Geometry, Introduction to vector valued functions of one independent variable, Operations with vector-valued functions of one independent variable,

UNIT I I

Vector Differentiation, Gradient, Divergence and Curl, Normal on a surface, Directional Derivative,

UNIT III

Vector Integration, Theorems of Gauss, Green, Stokes and related problems.

Course Specific Outcomes:

After completion of this course a student would have

1. a vast knowledge of Calculus which they can use for their furtherstudy.
2. a clear idea of characterizations of two dimensional as well as three dimensional geometry.
3. a clear concept of vector analysis and its applications

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Semester III

Multidisciplinary Course (MDC)

A- Linear Programming and It's Applications

OR

B- Introduction to Information Theory and Coding

Course Name: Introduction to Linear Programming	**Course Code:** M-DIS-LP

Credits = L+T+P (3+1+0)	**Hours (Total) =45**

Course Objectives: This course develops the ideas underlying the Simplex Method for Linear Programming Problem, as an important branch of Operations Research. The course covers Linear Programming with applications Such problems arise in manufacturing resource planning and financial sectors.

Course Contents:

Unit 1
Introduction to linear programming problem. Theory of simplex method, graphical solution, convex sets, optimality and unboundedness.

Unit 2
The simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method. Big-M method and their comparison.

Unit 3
Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual.

Course Learning Outcomes: This course will enable the students to learn:

1. Analyze and solve linear programming models of real life situations.
2. The graphical solution of LPP with only two variables, and illustrate the concept of convex set and extreme points. The theory of the Simplex Method is developed.

Reference Books

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows, 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006.
4. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.

OR

Semester III

Course Name: Introduction to Information Theory and Coding	**Course Code:** M-DIS IT

Credits = L+T+P (3+1+0)	**Hours (Total) =45**

Course Objectives: This course aims to introduce the basic aspects of Information Theory and Coding to the students. Shannon's work form the underlying theme for the present course. Construction of finite fields and bounds on the parameters of a linear code discussed.

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Course Contents:

Unit 1: Concepts of Information Theory

Communication processes, A model of communication system, A quantitative measure of information, Binary unit of information, A measure of uncertainty, H function as a measure of uncertainty, Sources and binary sources, Measure of information for two-dimensional discrete finite probability schemes.

Unit 2: Entropy Function

A sketch of communication network, Entropy, Basic relationship among different entropies, A measure of mutual information, Interpretation of Shannon's fundamental inequalities; Redundancy, Efficiency and channel capacity, Binary symmetric channel, Binary erasure channel, Uniqueness of the entropy function, Joint entropy and conditional entropy, Relative entropy and mutual information, Relationship between entropy and mutual information, Chain rules for entropy, Relative entropy and mutual information, Jensen's inequality and its characterizations, The log sum inequality and its applications.

Unit 3: Concepts of Coding

Block codes, Hamming distance, Maximum likelihood decoding, Levels of error handling, Error correction, Error detection, Erasure correction, Construction of finite fields, Linear codes, Matrix representation of linear codes.

Unit 4: Bounds of Codes

Orthogonality relation, Encoding of linear codes, Decoding of linear codes, The singleton bound and maximum distance separable codes, The sphere-packing bound and perfect codes, The Gilbert-Varshamov bound, MacWilliams' identities.

Course Learning Outcomes: This course will enable the students to learn:

1. The output of the channel, a received signal is observed.
2. The detection & correction of errors while transmission.
3. Representation of a linear code by matrices and its encoding and decoding.

References:

1. Cover, Thomas M., & Thomas, Joy A. (2006). *Elements of Information Theory* (2nd ed.). Wiley India. Indian Reprint 2014.
2. Gallian, Joseph. A. (2013). *Contemporary Abstract Algebra* (8th ed.). Cengage Learning India Private Limited. Delhi. Fourth impression, 2015.
3. Reza, Fazlollah M. (1961). *An Introduction to Information Theory*. Dover Publications Inc, New York. Reprint 1994.
4. Roth, Ron M. (2007). *Introduction to Coding Theory*. Cambridge University Press.

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Semester III

Skill Enhancement Course (SEC)-I1I

A- Computer Algebra Systems and Related Software's

OR

B- Basic Numerical Methods

OR

C- LaTeX and HTML

Course Name: Computer Algebra Systems and Related Software's	**Course Code:** SEC-CA
Credits = L+T+P (3+1+0)	**Hours (Total) =45**

Course Objectives: This course aims at familiarizing students with the usage of computer algebra systems (/Mathematica/MATLAB/Maxima/Maple) and the statistical software **R**. The basic emphasis is on plotting and working with matrices using CAS. Data entry and summary commands will be studied in **R**. Graphical representation of data shall also be explored.

Course Contents:

Unit 1: Introduction to CAS and Applications

Computer Algebra System (CAS), Use of a CAS as a calculator, Computing and plotting functions in 2D, Plotting functions of two variables using Plot3D and ContourPlot, Plotting parametric curves surfaces, Customizing plots, Animating plots, Producing tables of values, working with piecewise defined functions, Combining graphics.

Unit 2: Working with Matrices

Simple programming in a CAS, Working with matrices, Performing Gauss elimination, operations (transpose, determinant, inverse), Minors and cofactors, Working with large matrices, Solving system of linear equations, Rank and nullity of a matrix, Eigen value, eigenvector and diagonalization.

Unit 3: R - The Statistical Programming Language

R as a calculator, Explore data and relationships in **R.** Reading and getting data into **R:** Combine and scan commands, Types and structure of data items with their properties. Manipulating vectors, Data frames, Matrices and lists. Viewing objects within objects. Constructing data objects and conversions.

Unit 4: Data Analysis with R

Summary commands**:** Summary statistics for vectors, Data frames, Matrices and lists. Summary tables. Stem and leaf plot, Histograms. Plotting in **R:** Box-whisker plots, Scatter plots, Pairs plots, Line charts, Pie charts, Cleveland dot charts and bar charts. Copy and save graphics to other applications.

Course Learning Outcomes: This course will enable the students to:

1. Use CAS as a calculator, for plotting functions, animations and various applications of matrices.
2. Understand the use of the software **R** for entry, summary calculation, pictorial representation of data and exploring relationship between data.
3. Analyze, test, and interpret technical arguments on the basis of geometry.

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1. Bindner, Donald & Erickson, Martin. (2011). *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*. CRC Press, Taylor & Francis Group, LLC.
2. Torrence, Bruce F., & Torrence, Eve A. (2009). *The Student's Introduction to Mathematica®: A Handbook for Precalculus, Calculus, and Linear Algebra* (2nd ed.). Cambridge University Press.
3. Gardener, M. (2012). *Beginning R*: *The Statistical Programming Language*, Wiley.

OR

Semester III

Course Name: Basic Numerical Methods	**Course Code:** SEC-BN

Credits = L+T+P (3+1+0)	**Hours (Total) =45**

Course Objectives: The course will enable the students to obtain numerical solutions of algebraic and transcendental equations. Find numerical solutions of system of linear equations and check the accuracy of the solutions. Learn about various interpolating and extrapolating methods.

Course Contents:

Unit1

Approximate numbers and Significant figure, Computational errors: Rounding, Truncation, Absolute, Relative and Percentage errors, Forward and backward differences, different operators, Interpolation, Error in interpolation,

Unit2

Newton's forward, backward interpolations, Newton's divided difference, Lagrange's interpolation.

.

Unit 3

Solution of Algebraic and Transcendental equations: Bisection, Fixed Point Iteration method, Geometry, Convergency, Newton Raphson's method, Geometry, Convergency, Method of False Position.

Course Specific Outcomes: This course specifically enables the students to:

1. solve initial and boundary value problems in differential equations using numerical methods.
2. apply various numerical methods in real life problems.

Reference Books

1. B. Bradie, A Friendly Introduction to Numerical Analysis. Pearson, 2006.
2. C.F. Gerald & P. O. Wheatley, Applied Numerical Analysis (7th edition), Pearson Education, India, 2008.
3. F.B. Hildebrand, Introduction to Numerical Analysis: (2nd edition). Dover Publications, 2013.
4. M.K. Jain, S.R.K. Iyengar & R.K. Jain, Numerical Methods for Scientific

OR

Semester III

Course Name: LaTeX and HTML	**Course Code:** SEC-LH

Credits = L+T+P (3+1+0)	**Hours (Total) =45**

Course Objectives: The purpose of this course is to acquaint students with the latest typesetting skills, which shall enable them to prepare high quality typesetting, beamer presentation and webpages.

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Course Contents:

Unit 1: Getting Started with LaTeX
Introduction to TeX and LaTeX, Typesetting a simple document, Adding basic information to a document, Environments, Footnotes, Sectioning and displayed material.

Unit 2: Mathematical Typesetting with LaTeX
Accents and symbols, Mathematical Typesetting (Elementary and Advanced)**:** Subscript/ Superscript, Fractions, Roots, Ellipsis, Mathematical Symbols, Arrays, Delimiters, Multiline formulas, Spacing and changing style in math mode.

Unit 3: Graphics and Beamer Presentation in LaTeX
Graphics in LaTeX, Simple pictures using PS Tricks, Plotting of functions, Beamer presentation.

Unit 4: HTML
HTML basics, Creating simple web pages, Images and links, Design of web pages.

Course Learning Outcomes: After studying this course the student will be able to:

1. Typeset mathematical formulas, use nested list, tabular & array environments.
2. Create or import graphics.
3. Use beamer to create presentation and HTML to create a web page.

References:

1. Bindner, Donald & Erickson, Martin. (2011). *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*. CRC Press, Taylor & Francis Group, LLC.
2. Lamport, Leslie (1994). *LaTeX*: *A Document Preparation System*, User's Guide and

   Reference Manual (2nd ed.). Pearson Education. Indian Reprint.

Ability Enhancement Course (AEC)- III

Course Name: Disaster Risk Management	**Course Code:** AEC- DR

Credits =L+T+P (2+1+0)	**Hours (Total) =30**

Semester IV
Major Course V

Course Name: Modern Algebra	**Course Code:** BSMT - 401

Credits =L+T+P (5+1+0)	**Hours (Total) =75**

Course Objectives: The objective of the course is to introduce the fundamental theory of groups and their homomorphisms. Symmetric groups and group of symmetries are also studied in detail. Fermat's Little theorem as a consequence of the Lagrange's theorem on finite groups.

Course Contents:

Unit 1: Groups and its Elementary Properties

Symmetries of a square, The Dihedral groups, Definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), Elementary properties of groups.

Unit 2: Subgroups and Cyclic Groups

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Subgroups and examples of subgroups, Centralizer, Normalizer, Center of a group, Product of two subgroups; Properties of cyclic groups, Classification of subgroups of cyclic groups.

Unit 3: Permutation Groups and Lagrange's Theorem

Cycle notation for permutations, Properties of permutations, Even and odd permutations, alternating groups; Properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem; Normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

Unit 4: Group Homomorphisms

Group homomorphisms, Properties of homomorphisms, Group isomorphisms, Cayley's theorem, Properties of isomorphisms, First, Second and Third isomorphism theorems for groups.

Unit 5:

Definition and examples of rings, Properties of rings, Subrings, Integral domains and fields, characteristic of a ring. Ideals, Ideal generated by a subset of a ring, Factor rings, Operations on ideals, Prime and maximal ideals.

Course Learning Outcomes: The course will enable the students to:

1. Recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutation groups, etc;
2. Link the fundamental concepts of Groups and symmetrical figures;
3. Analyze the subgroups of cyclic groups;
4. Explain the significance of the notion of cosets, normal subgroups, and factor groups.

Reference:

1. Gallian, Joseph. A. (2013). *Contemporary Abstract Algebra* (8th ed.). Cengage Learning India Private Limited, Delhi. Fourth impression, 2015.

Additional Reading:

1. Rotman, Joseph J. (1995). *An Introduction to The Theory of Groups* (4th ed.). Springer Verlag, New York.

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Semester IV

Major Course VI

Course Name: Mathematical Methods	**Course Code:** BSMT 402

Credits =L+T+P (5+1+0)	**Hours (Total) =75**

Course Objectives: The course will enable the students to know about piecewise continuous functions, Dirac delta function, Laplace transforms and its properties. Solve ordinary differential equations using Laplace transforms. Familiarize with Fourier transforms of functions, relation between Laplace and Fourier transforms. Explain Parseval's identity, Plancherel's theorem and applications of Fourier transforms to boundary value problems.

Course Contents:

Unit 1

Laplace transform, Linearity, Existence theorem, Laplace transforms of derivatives and integrals, Shifting theorems, Change of scale property, Laplace transforms of periodic functions, Dirac delta function.

Unit 2

Differentiation and integration of transforms, Convolution theorem, Integral equations, Inverse Laplace transform, Lerch's theorem, Linearity property of inverse Laplace transform, Translations theorems of inverse Laplace transform, Inverse transform of derivatives, Applications of Laplace transform in obtaining solutions of ordinary differential equations and integral equations.

Unit 3

Fourier and inverse Fourier transforms, Fourier sine and cosine transforms, Inverse Fourier sine and cosine transforms, Linearity property, Change of scale property, Shifting property, Modulation theorem, Relation between Fourier and Laplace transforms.

Unit 4

Solution of integral equations by Fourier sine and cosine transforms, Convolution theorem for Fourier transform, Parseval's identity for Fourier transform, Plancherel's theorem, Fourier transform of derivatives, Applications of infinite Fourier transforms to boundary value problems, Finite Fourier transform, Inversion formula for finite Fourier transforms.

Unit 5

Fourier cosine and sine series, Fourier series, Differentiation and integration of Fourier series, Absolute and uniform convergence of Fourier series, Bessel's inequality, The complex form of Fourier series.

Course Specific Outcomes: The student acquires the knowledge of

2. Fourier series, Bessel's inequality, term by term differentiation and integration of Fourier Series,
3. application of this course in real life problems

Reference Books

1. J.W. Brown & R.V. Churchill, Fourier Series and Boundary Value Problems, McGraw-Hill Education, 2011.
2. C.K. Chui, An Introduction to Wavelets. Academic Press, 1992.
3. E. Kreyszig, Advanced Engineering Mathematics, 10th Ed., Wiley, 2011.
4. W. Rudin, Fourier Analysis on Groups, Dover Publications, 2017.
5. A. Zygmund, Trigonometric Series, 3rd Ed., Cambridge University Press, 2002.

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Semester IV

Major Course VII

Course Name: Mechanics	**Course Code:** BSMT 403

Credits =L+T+P (5+1+0)	**Hours (Total) =75**

Course Objectives: The course aims at understanding the various concepts of physical quantities and the related effects on different bodies using mathematical techniques. It emphasizes knowledge building for applying mathematics in physical world.

Course Contents:

Unit 1: Forces in Equilibrium

Coplanar force systems; Three-dimensional force systems; Moment of a force about a point and an axis, Principle of moments, Couple and couple moment, Moment of a couple about a line, Resultant of a force system, Distributed force system, Rigid-body equilibrium, Equilibrium of forces in two and three dimensions, Free-body diagrams, General equations of equilibrium, Constraints and statical determinacy.

Unit 2: Friction, Center of Gravity and Moments of Inertia

Equations of equilibrium and friction, Frictional forces on screws and flat belts; Center of gravity, Center of mass and Centroid of a body and composite bodies; Theorems of Pappus and Guldinus; Moments and products of inertia for areas, composite areas and rigid body, Parallel-axis theorem, Moment of inertia of a rigid body about an arbitrary axis, Principal moments and principal axes of inertia.

Unit 3: Conservation of Energy and Applications

Conservative force fields, Conservation of mechanical energy, Work-energy equations, Kinetic energy and work-kinetic energy expressions based on center of mass, Moment of momentum equation for a single particle and a system of particles.

Unit 4: Rigid Body Motion

Translation and rotation of rigid bodies, Chasles' Theorem, General relationship between time derivatives of a vector for different references, Relationship between velocities of a particle for different references, Acceleration of particle for different references.

Course Learning Outcomes: The course will enable the students to understand:

1. The significance of mathematics involved in physical quantities and their uses;
2. To study and to learn the cause-effect related to these; and
3. The applications in observing and relating real situations/structures.

References:

1. Hibbeler, R. C. (2016). *Engineering Mechanics*: *Statics & Dynamics* (14th ed.). Pearson Prentice Hall (Pearson Education), New Jersey.
2. Shames, Irving H., & Rao, G. Krishna Mohan (2009). *Engineering Mechanics*: *Statics and Dynamics* (4th ed.). Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

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Semester IV

Minor Course IV

Course Name: Graph Theory	**Course Code:** BSMT 404

Credits =L+T+P (3+1+0)	**Hours (Total) =45**

Course Objectives: The course will enable the students to study graph theory with various types of graphs and their application. Study the mathematical applications to the real world.

Course Contents:

Unit 1
Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs isomorphism of graphs.

Unit 2
Eulerian circuits, Eulerian graph, semi-Eulerian graph, theorems, Hamiltonian cycles, theorems Representation of a graph by matrix, the adjacency matrix, incidence matrix, weighted graph,

Unit 3
Travelling salesman's problem, shortest path, Tree and their properties, spanning tree, Dijkstra's algorithm, Warshall algorithm.

Course Learning Outcomes: The student acquires the knowledge of:

1. path and circuits of the Graph theory specifically Eulerian circuits.
2. shortest path and the problem of Travelling salesman.

Reference Books

1. B.A. Davey and H.A. Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge, 1990.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 2nd Edition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
3. Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

Semester IV

Ability Enhancement Course (AEC)- IV

Course Name: Course on NCC/NSS/NGO'S/Scout Guide's/ Sports	**Course Code:** AEC-

Credits =L+T+P (2+1+0)	**Hours (Total) =30**

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KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

Department of Mathematics

Batch:2025 -26			Programe Name - B.Sc.- Mathematics					SEM:V						
S.No.	Course Type	Course Code	Course Name	Teaching Load			Credits		Internal Assessment		External Assessment	Total	Remark
				L	T	P							
THEORY and PRACTICAL SUBJECTS								Attendance (5)	quiz/PPT/Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)		
1	MJC-8	BSMT-501	Real Analysis-I	5	0	0	5	5	10	15	70	100	
2	MJC-9	BSMT-502	Numerical Analysis	5	0	0	5	5	10	15	70	100	
3	MIC-5	BSMT-503	Linear Programming and It's Applications	3	0	0	3	5	10	15	70	100	
4	MIC-6	BSMT-504	Introductory Probability	3	0	0	3	5	10	15	70	100	
5	INT	BSMT-505I	Internship	1	0	6	4	5	10	15	70	100	
TOTAL CREDITS / ASSESSMENT							20	25	50	75	350	500	

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Department of Mathematics

Batch:2025-26	Program Name - B.Sc.- Mathematics		SEM:VI

S.No.	Course Type	Course Code	Course Name	Teaching Load			Credits		Internal Assessment		External Assessment	Total	Remark
				L	T	P							
THEORY and PRACTICAL SUBJECTS								Attendance (5)	quiz/PPT/Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)		
1	MJC-10	BSMT-601	Metric Spaces	4	0	0	4	5	10	15	70	100	
2	MJC-11	BSMT-602	Linear Algebra	5	0	0	5	5	10	15	70	100	
3	MJC-12	BSMT-603	Real Analysis -II	5	0	0	5	5	10	15	70	100	
4	MIC-7	BSMT-604	Theory of Real Functions	3	0	0	3	5	10	15	70	100	
5	MIC-8	BSMT-605	Applied Statistics	3	0	0	3	5	10	15	70	100	
TOTAL CREDITS / ASSESSMENT							20	25	50	75	350	500	

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Semester V
Major Course VIII

Course Name: Real Analysis-I	**Course Code:** BSMT 501

Credits =L+T+P (5+1+0)	**Hours (Total) =75**

Course Objectives: The course will develop a deep and rigorous understanding of real line R and of defining terms to prove the results about convergence and divergence of sequences and series of real numbers. These concepts have wide range of applications in real life scenario.

Course Contents:

Unit 1: Real Number System R

Algebraic and order properties of R, Absolute value of a real number; Bounded above and bounded below sets, Supremum and infimum of a nonempty subset of R.

Unit 2: Properties of R

The completeness property of R, Archimedean property, Density of rational numbers in R, Definition and types of intervals, Nested intervals property; Neighborhood of a point in Open and closed sets in R .

Unit 3: Sequences in R

Convergent sequence, Limit of a sequence, Bounded sequence, Limit theorems, Monotone sequences, Monotone convergence theorem, Subsequences, Bolzano-Weierstrass theorem for sequences, Limit superior and limit inferior for bounded sequence, Cauchy sequence, Cauchy's convergence criterion.

Unit 4: Infinite Series

Convergence and divergence of infinite series of real numbers, Necessary condition for convergence, Cauchy criterion for convergence; Tests for convergence of positive term series**:** Integral test, Basic comparison test, Limit comparison test, D'Alembert's ratio test, Cauchy's *n*th root test; Alternating series, Leibniz test, Absolute and conditional convergence.

Course Learning Outcomes: This course will enable the students to:

1. Understand many properties of the real line R and learn to define sequence in terms of functions from N to a subset of R.
2. Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.
3. Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

References:

1. Bartle, Robert G., & Sherbert, Donald R. (2015). *Introduction to Real Analysis* (4th ed.). Wiley India Edition. New Delhi.
2. Bilodeau, Gerald G., Thie, Paul R., & Keough, G. E. (2010). *An Introduction to Analysis* (2nd ed.). Jones and Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.
3. Denlinger, Charles G. (2011). *Elements of Real Analysis*. Jones and Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.

Additional Readings:

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1. Ross, Kenneth A. (2013). *Elementary Analysis*: *The theory of calculus* (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian Reprint.

2. Thomson, Brian S., Bruckner, Andrew. M., & Bruckner, Judith B. (2001). *Elementary Real Analysis.* Prentice Hall.

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Semester V

Major Course IX

Course Name: Numerical Analysis	**Course Code:** BSMT 502

Credits =L+T+P (5+1+0)	**Hours (Total) =75**

Course Objectives: The goal of this paper is to acquaint students for the study of certain algorithms that uses numerical approximation for the problems of mathematical analysis. Also, the use of Computer Algebra Systems (CAS) by which the intractable problems can be solved both numerically and analytically.

Unit I:

Floating point representation and computer arithmetic, Significant digits, Errors: Roundoff error, Local truncation error, Global truncation error, Order of a method, Convergence and terminal conditions, Efficient computations Bisection method, Secant method, Regula Falsi method, Newton-Raphson method, Newton's method for solving nonlinear systems

Unit II:

Gauss elimination method (with row pivoting) and Gauss-Jordan method, Gauss Thomas method for tridiagonal systems Iterative methods: Jacobi and Gauss-Seidel iterative methods
Interpolation: Lagrange's form and Newton's form Finite difference operators, Gregory Newton forward and backward differences Interpolation

Unit III:

Piecewise polynomial interpolation: Linear interpolation, Cubic spline interpolation (only method),
Numerical differentiation: First derivatives and second order derivatives, Richardson extrapolation
Numerical integration: Trapezoid rule, Simpson's rule (only method), Newton Cotes open formulas.

Unit IV:

Extrapolation methods: Romberg integration, Gaussian quadrature,
Ordinary differential equation: Euler's method Modified Euler's methods: Heun method and Mid-point method,
Runge-Kutta second methods: Heun method without iteration, Mid-point method and Ralston's method Classical 4th order Runge-Kutta method, Finite difference method for linear ODE.

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

1. Find the consequences of finite precision and the inherent limits of numerical methods.
2. Appropriate numerical methods to solve algebraic and transcendental equations.
3. How to solve first order initial value problems of ODE's numerically using Euler methods.
4.

REFERNCES:

1. Laurence V. Fausett, Applied Numerical Analysis, Using MATLAB, Pearson, 2/e (2012)
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publisher, 6/e (2012).
3. Steven C Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, Tata McGraw Hill, 2/e (2010)

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Semester V

Minor Course V

Course Name: Linear Programming and It's Applications	**Course Code:** BSMT 504

Credits = L+T+P (3+1+0)	**Hours (Total) =45**

Course Objectives: This course develops the ideas underlying the Simplex Method for Linear Programming Problem, as an important branch of Operations Research. The course covers Linear Programming with applications to Transportation, Assignment and Game Problem. Such problems arise in manufacturing resource planning and financial sectors

Unit 1
assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

Unit 2
Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games.

Unit 3
Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem,

Course Learning Outcomes: This course will enable the students to learn:

1. Analyze and solve linear programming models of real life situations.
2. The graphical solution of LPP with only two variables, and illustrate the concept of convex set and extreme points. The theory of the simplex method is developed.
3. The relationships between the primal and dual problems and their solutions with applications to transportation, assignment and two-person zero-sum game problem.

References:

1. Bazaraa, Mokhtar S., Jarvis, John J., & Sherali, Hanif D. (2010). *Linear Programming and Network Flows* (4th ed.). John Wiley and Sons.

2. Hadley, G. (1997). *Linear Programming*. Narosa Publishing House. New Delhi.
3. Taha, Hamdy A. (2010). *Operations Research*: *An Introduction* (9th ed.). Pearson.

Additional Readings:

1. Hillier, F. S. & Lieberman, G. J. (2010). *Introduction to Operations Research-Concepts and Cases* (9th ed.). Tata McGraw Hill.

2. Thie, Paul R., & Keough, G. E. (2014). *An Introduction to Linear Programming and Game Theory*. (3rd ed.). Wiley India Pvt. Ltd.

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Semester V

Minor Course VI

Course Name: Introductory Probability	**Course Code:** BSMT 505

Credits = L+T+P (3+1+0)	**Hours (Total) =45**

UNIT I

Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability – classical, statistical, and axiomatic. Conditional Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes' theorem and its applications.

UNIT II

Random Variables: Discrete and continuous random variables, p.m.f., p.d.f. ,c.d.f. Illustrations of random variables and its properties. Expectation, variance, moments and moment generating function.

UNIT III

Standard probability distributions: Binomial, Poisson, geometric, negative binomial, hypergeometric, uniform, normal, exponential, beta, gamma.

SUGGESTED READING:

1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.

2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

3. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi

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Semester V

INTERNSHIP

Course Name: Project Work /INT	**Course Code:** BSMT 503

Credits = L+T+P (4+1+0)	**Hours (Total) =150**

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Semester VI
Major Course X

Course Name: Metric Spaces	**Course Code: BSMT 601**

Credits =L+T+P (4+1+0)	**Hours (Total) =60**

Course Objectives: The course aims at providing the basic knowledge pertaining to metric spaces such as open and closed balls, neighborhood, interior, closure, subspace, continuity, compactness, connectedness etc.

Course Contents:

Unit 1: Basic Concepts

Metric spaces**:** Definition and examples, Sequences in metric spaces, Cauchy sequences, Complete metric space.

Unit 2: Topology of Metric Spaces

Open and closed ball, Neighborhood, Open set, Interior of a set, limit point of a set, derived set, closed set, closure of a set, diameter of a set, Cantor's theorem, Subspaces, Dense set.

Unit 3: Continuity & Uniform Continuity in Metric Spaces

Continuous mappings, Sequential criterion and other characterizations of continuity, Uniform continuity, Homeomorphism, Contraction mapping, Banach fixed point theorem.

Unit 4: Connectedness and Compactness

Connectedness, Connected subsets of R, Connectedness and continuous mappings, Compactness, Compactness and boundedness, Continuous functions on compact spaces.

Course Learning Outcomes: The course will enable the students to:

1. Understand the basic concepts of metric spaces;
2. Correlate these concepts to their counter parts in real analysis;

Appreciate the abstractness of the concepts such as open balls, closed balls, compactness, connectedness etc. beyond their geometrical imaginations.

Reference:

1. Shirali, Satish & Vasudeva, H. L. (2009). *Metric Spaces*, Springer, First Indian Print.

Additional Readings:

1. Kumaresan, S. (2014). *Topology of Metric Spaces* (2nd ed.). Narosa Publishing House. New Delhi.
2. Simmons, G. F. (2004). *Introduction to Topology and Modern Analysis*. Tata McGraw Hill. New Delhi.

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Semester VI
Major Course XI

Course Name: Linear Algebra	**Course Code: BSMT 602**

Credits =L+T+P (5+1+0)	**Hours (Total) =75**

Course Objectives: The objective of this course is to introduce the fundamental theory of one objects, namely vector spaces, and their corresponding homeomorphisms.

Course Contents:

Unit 1: Introduction of Vector Spaces

Vector spaces, Subspaces, Algebra of subspaces, Quotient spaces,

Unit 2:

Linear combination of vectors, Linear span, Linear independence, Basis and dimension, Dimension of subspaces.

Unit 2: Linear Transformations

Linear transformations, Null space, Range, Rank and nullity of a linear transformation,

Unit 4:

Matrix representation of a linear transformation, Algebra of linear transformations. Isomorphisms, Isomorphism theorems, Invertibility and the change of coordinate matrix.

Course Learning Outcomes: The course will enable the students to learn about:

1. The concept of linear independence of vectors over a field, the idea of a finite dimensional vector space,
2. The concept of linear independence of vectors over a field, basis of a vector space and the dimension of a vector space.
3. Basic concepts of linear transformations, the Rank-Nullity Theorem, matrix of a linear transformation,
4. Basic concepts of linear transformations algebra of transformations and the change of basis.

References:

1. Gallian, Joseph. A. (2013). *Contemporary Abstract Algebra* (8th ed.). Cengage Learning India Private Limited. Delhi. Fourth impression, 2015.
2. Friedberg, Stephen H., Insel, Arnold J., & Spence, Lawrence E. (2003). *Linear Algebra* (4th ed.). Prentice-Hall of India Pvt. Ltd. New Delhi.

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Semester VI

Major Course XII

Course Name: Real Analysis-II	**Course Code: BSMT 603**

Credits =L+T+P (5+1+0)	**Hours (Total) =75**

Course Objectives: To understand the integration of bounded functions on a closed and bounded interval and its extension to the cases where either the interval of integration is infinite, or the integrand has infinite limits at a finite number of points on the interval of integration. The sequence and series of real valued functions, and an important class of series of functions (i.e., power series).

Course Contents:

Unit 1: Riemann Integration

Definition of Riemann integration, Inequalities for upper and lower Darboux sums, Necessary and sufficient conditions for the Riemann integrability, Definition of Riemann integration by Riemann sum and equivalence of the two definitions, Riemann integrability of monotone functions and continuous functions, Properties of Riemann integrable functions, Definitions of piecewise continuous and piecewise monotone functions and their Riemann integrability, intermediate value theorem for integrals, Fundamental theorems (I and II) of calculus, and the integration by parts.

Unit 2: Improper Integral

Improper integrals of Type-I, Type-II and mixed type, Convergence of Beta and Gamma functions, and their properties.

Unit 3: Sequence and Series of Functions

Pointwise and uniform convergence of sequence of functions, Theorem on the continuity of the limit function of a sequence of functions, Theorems on the interchange of the limit and derivative, and the interchange of the limit and integrability of a sequence of functions. Pointwise and uniform convergence of series of functions, Theorems on the continuity, Derivability and integrability of the sum function of a series of functions, Cauchy criterion and the Weierstrass M-Test for uniform convergence.

Unit 4: Power Series

Definition of a power series, Radius of convergence, Absolute convergence (Cauchy-Hadamard theorem), Uniform convergence, Differentiation and integration of power series, Abel's Theorem.

Course Learning Outcomes: The course will enable the students to learn about:

1. Some of the families and properties of Riemann integrable functions, and the applications of the fundamental theorems of integration.
2. Beta and Gamma functions and their properties.
3. The valid situations for the inter-changeability of differentiability and integrability with infinite sum, and approximation of transcendental functions in terms of power series.

References:

1. Bartle, Robert G., & Sherbert, Donald R. (2015). *Introduction to Real Analysis* (4th ed.). Wiley India Edition. Delhi.
2. Denlinger, Charles G. (2011). *Elements of Real Analysis*. Jones and Bartlett (Student Edition). First Indian Edition. Reprinted 2015.

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3. Ghorpade, Sudhir R. & Limaye, B. V. (2006). *A Course in Calculus and Real Analysis*. Undergraduate Texts in Mathematics, Springer (SIE). First Indian reprint.

4. Ross, Kenneth A. (2013). *Elementary Analysis*: *The Theory of Calculus* (2nd ed.). Undergraduate Texts in Mathematics, Springer.

Semester VI
Minor Course VII

Course Name: Theory of Real Functions	**Course Code:** BSMT 604

Credits = L+T+P (3+1+0)	**Hours (Total) =45**

Unit 1

Limits of functions (ε - δ approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity and discontinuity. Algebra of continuous functions. Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.

Unit 2

Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, interior extremum theorem. Rolle's theorem. Mean value theorem, intermediate value property of derivatives, Darboux's theorem. Applications of mean value theorem to inequalities and approximation of polynomials.

Unit 3

Cauchy's mean value theorem. Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to convex functions, relative extrema. Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions, ln(1 + x), 1/ax+b and (1 +x)n. Application of Taylor's theorem to inequalities.

Semester VI
Minor Course VIII

Course Name: Applied Statistics	**Course Code:** BSMT 605

Credits = L+T+P (3+1+0)	**Hours (Total) = 45**

UNIT I : Economic Time Series: Components of time series, Decomposition of time series- Additive and multiplicative model with their merits and demerits, Illustrations of time series. Measurement of trend by method of free-hand curve, method of semi-averages and method of least squares (linear, quadratic and modified exponential).Measurement of seasonal variations by method of ratio to trend.

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UNIT II : Index numbers: Definition, Criteria for a good index number, different types of index numbers. Construction of index numbers of prices and quantities, consumer price index number. Uses and limitations of index numbers.

UNIT III : Statistical Quality Control: Importance of statistical methods in industrial research and practice. Determination of tolerance limits. Causes of variations in quality: chance and assignable. General theory of control charts, process & product control, Control charts for variables: X- bar and R-charts. Control charts for attributes: p and c-charts

UNIT IV : Demographic Methods: Introduction, measurement of population, rates and ratios of vital events. Measurement of mortality: CDR, SDR (w.r.t. Age and sex), IMR, Standardized death rates. Life (mortality) tables: definition of its main functions and uses. Measurement of fertility and reproduction: CBR, GFR, and TFR. Measurement of population growth: GRR, NRR.

SUGGESTED READING:

1. Mukhopadhyay, P. (1999): Applied Statistics, New Central Book Agency, Calcutta.

2 Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9 th Edition World Press, Kolkata.

3. Gupta, S. C. and Kapoor, V.K. (2008): Fundamentals Of Applied Statistics, 4 Edition(Reprint), Sultan Chand & Sons

4. Montogomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition Wiley India Pvt. Ltd.

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KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

Department of Mathematics,

Batch:2025-26			**Programe Name - B.Sc.- Mathematics**					**SEM:VII**						
S.No.	**Course Type**	**Course Code**	**Course Name**	**Teaching Load**			**Credits**		**Internal Assessment**		**External Assessment**	**Total**	**Remark**
				L	**T**	**P**							
THEORY and PRACTICAL SUBJECTS								**Attendance (5)**	**quiz/PPT/Assignment (10)**	**Mid Sem Test (15)**	**End Sem Exam (70)**		
1	**MJC-13**	BSMT-701	Probability Theory & Statistics	5	0	0	**5**	5	10	15	70	100	
2	**MJC-14**	BSMT-702	Discrete Mathematics	5	0	0	**5**	5	10	15	70	100	
3	**MJC-15**	BSMT-703	Optimization Technique and Game Theory	4	**0**	0	**4**	5	10	15	70	100	
4	**MIC-9**	BSMT-704	Differential Geometry	4	**0**	0	**4**	5	10	15	70	100	
5	**MJC-P**	BSMT-705P	Mathematical Tools Practical	0	0	4	**2**	5	10	15	70	100	
TOTAL CREDITS / ASSESSMENT							**20**	**25**	**50**	**75**	**350**	**500**	

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KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

Department of Mathematics,

Batch:2025-26			Programe Name - B.Sc.- Mathematics				SEM:VIII						
S.No.	Course Type	Course Code	Course Name	Teaching Load			CREDITS	Internal Assessment			External Assessment	Total	Remark
	THEORY and PRACTICAL SUBJECTS			L	T	P		Attendance (5)	Quiz/PPT/ Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)		
1	MJC-16	BSMT-801	Complex Analysis	4	0	0	4	5	10	15	70	100	
2	MIC-10	BSMT-802	Formal Language and Automata	4	0	0	4	5	10	15	70	100	
3	RP-1	BSMT-803R	Research Project / Dissertation	6	0	12	12	5	10	15	70	100	
TOTAL CREDITS / ASSESSMENT							20	15	30	45	210	300	
			Total	IVYEAR	38	2	8	48	40	240	560	800	
			Total	I YEAR	44	2	13	59	40	390	910	1300	
			Total	IIYEAR	43	0	11	54	40	330	770	1100	
			Total	III YEAR	42	0	10	52	40	300	700	1000	
			GRAND TOTAL	I TO IV YEARS	167	4	42	213	160	1260	2940	4200	

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Semester VII
Major Course XIII

Course Name: Probability Theory & Statistics	**Course Code: BSMT-701**

Credits =L+T+P (5+1+0)	**Hours (Total) =75**

Course Objectives: To make the students familiar with the basic statistical concepts and tools which are needed to study situations involving uncertainty or randomness. The course intends to render the students to several examples and exercises that blend their everyday experiences with their scientific interests.

Course Contents:

Unit 1: Probability Functions and Moment Generating Function

Sample space, Probability set function, Real random variables - Discrete and continuous, Cumulative distribution function, Probability mass/density functions, Transformations, Mathematical expectation, Moments, Moment generating function, Characteristic function.

Unit 2: Univariate Discrete and Continuous Distributions

Discrete distributions**:** Uniform, Bernoulli, Binomial, Negative binomial, Geometric and Poisson; Continuous distributions**:** Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution.

Unit 3: Bivariate Distribution

Joint cumulative distribution function and its properties, Joint probability density function, Marginal distributions, Expectation of function of two random variables, Joint moment generating function, Conditional distributions and expectations.

Unit 4: Correlation, Regression and Central Limit Theorem

The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Independent random variables, Linear regression for two variables, The method of least squares, Bivariate normal distribution, Chebyshev's theorem, Strong law of large numbers, Central limit theorem and weak law of large numbers.

Course Learning Outcomes: This course will enable the students to learn:

1. Distributions to study the joint behavior of two random variables.
2. To establish a formulation helping to predict one variable in terms of the other, i.e., correlation and linear regression.
3. Central limit theorem, which helps to understand the remarkable fact that**:** the empirical frequencies of so many natural populations, exhibit a bell shaped curve.

References:

1. Hogg, Robert V., McKean, Joseph W., & Craig, Allen T. (2013). *Introduction to Mathematical Statistics* (7th ed.). Pearson Education, Inc.
2. Miller, Irwin & Miller, Marylees. (2014). John E. Freund's *Mathematical Statistics with Applications* (8th ed.). Pearson. Dorling Kindersley (India).
3. Ross, Sheldon M. (2014). *Introduction to Probability Models* (11th ed.). Elsevier Inc. AP.

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Semester VII

Major Course XIV

Course Name: Discrete Mathematics	**Course Code:** BSMT 702

Credits =L+T+P (5+1+0)	**Hours (Total) =75**

Course Objectives: This course aims at introducing the concepts of lattices, Boolean algebras, switching circuits and graph theory. The course discusses some important applications of Boolean algebra and graph theory in real life situations through switching circuits and shortest path algorithms.

Course Contents:

Unit 1: Ordered Sets

Definitions, Examples and basic properties of ordered sets, Order isomorphism, Hasse diagrams, Dual of an ordered set, Duality principle, Maximal and minimal elements, Building new ordered sets, Maps between ordered sets.

Unit 2: Lattices

Lattices as ordered sets, Lattices as algebraic structures, Sublattices, Products and homomorphisms; Definitions, Examples and properties of modular and distributive lattices, The M3 – N5 Theorem with applications, Complemented lattice, Relatively complemented lattice, Sectionally complemented lattice.

Unit 3: Boolean Algebras and Switching Circuits

Boolean Algebras, De Morgan's laws, Boolean homomorphism, Representation theorem; Boolean polynomials, Boolean polynomial functions, Disjunctive normal form and conjunctive normal form, Minimal forms of Boolean polynomial, Quinn-McCluskey method, Karnaugh diagrams, Switching circuits and applications of switching circuits.

Unit 4: Graph Theory

Introduction to graphs, Konigsberg Bridge problem, Instant insanity game; Definition, examples and basic properties of graphs, Subgraphs, Pseudographs, Complete graphs, Bipartite graphs, Isomorphism of graphs, Paths and circuits, Eulerian circuits, Hamiltonian cycles, Adjacency matrix, Weighted graph, Travelling salesman problem, Shortest path, Dijkstra's algorithm.

Course Learning outcomes: After the course, the student will be able to understand the concepts of:

1. Lattices and their types;
2. Boolean algebra, switching circuits and their applications;
3. Graphs, their types and its applications in study of shortest path algorithms.

References:

1. Davey, B. A., & Priestley, H. A. (2002). *Introduction to lattices and order* (2nd ed.). Cambridge University press, Cambridge
2. Goodaire, Edgar G., & Parmenter, Michael M. (2011). *Discrete Mathematics with graph theory* (3rd ed.). Pearson Education (Singapore) Pvt. Ltd. Indian Reprint.
3. Lidl, Rudolf & Pilz, Gunter. (2004). *Applied Abstract Algebra* (2nd ed.), Undergraduate Texts in Mathematics. Springer (SIE). Indian Reprint.
4. Rosen, Kenneth H. (2012). *Discrete Mathematics and its applications, with combinatorics and graph theor*y. (7th ed.). McGraw Hill Education. Indian Reprint.

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Semester VII

Major Course XV

Course Name: Optimization Technique and Game Theory	**Course Code: BSMT 703**

Credits =L+T+P (4+1+0)	**Hours (Total) =60**

Course Objectives: This course develops the ideas underlying the Simplex Method for Linear Programming Problem, as an important branch of Operations Research. The course covers Linear Programming with applications to Transportation, Assignment and Game Problem. Such problems arise in manufacturing resource planning and financial sectors.

Course Contents:

Unit 1: Introduction to Linear Programming

The Linear Programming Problem**:** Standard, Canonical and matrix forms, Graphical solution. Hyperplanes, Extreme points, Convex and polyhedral sets. Basic solutions; Basic Feasible Solutions; Reduction of any feasible solution to a basic feasible solution; Correspondence between basic feasible solutions and extreme points.

Unit 2: Methods of Solving Linear Programming Problem

Simplex Method**:** Optimal solution, Termination criteria for optimal solution of the Linear Programming Problem, Unique and alternate optimal solutions, Unboundedness; Simplex Algorithm and its Tableau Format; Artificial variables, Two-phase method, Big-M method.

Unit 3: Duality Theory of Linear Programming

Motivation and Formulation of Dual problem; Primal-Dual relationships; Fundamental Theorem of Duality; Complimentary Slackness.

Unit 4: Applications

Transportation Problem**:** Definition and formulation; Methods of finding initial basic feasible solutions; North West corner rule. Least cost method; Vogel's Approximation method; Algorithm for solving Transportation Problem.

Assignment Problem**:** Mathematical formulation and Hungarian method of solving.

Game Theory**:** Basic concept, Formulation and solution of two-person zero-sum games, Games with mixed strategies, Linear Programming method of solving a game.

Course Learning Outcomes: This course will enable the students to learn:

1. Analyze and solve linear programming models of real life situations.
2. The graphical solution of LPP with only two variables, and illustrate the concept of convex set and extreme points. The theory of the simplex method is developed.
3. The relationships between the primal and dual problems and their solutions with applications to transportation, assignment and two-person zero-sum game problem.

References:

1. Bazaraa, Mokhtar S., Jarvis, John J., & Sherali, Hanif D. (2010). *Linear Programming and Network Flows* (4th ed.). John Wiley and Sons.
2. Hadley, G. (1997). *Linear Programming*. Narosa Publishing House. New Delhi.
1. Taha, Hamdy A. (2010). *Operations Research*: *An Introduction* (9th ed.). Pearson.

Additional Readings:

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2. Hillier, F. S. & Lieberman, G. J. (2010). *Introduction to Operations Research-Concepts and Cases* (9th ed.). Tata McGraw Hill.
3. Thie, Paul R., & Keough, G. E. (2014). *An Introduction to Linear Programming and Game Theory*. (3rd ed.). Wiley India Pvt. Ltd.

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Semester VII

Major Course - P

Course Name: Mathematical Tools Practical	**Course Code:** BSMT 705P

Credits =L+T+P (2+1+0)	**Hours (Total) =30**

Course Objectives: The primary objective of this course is to introduce the basic tools of theory of equations, complex numbers, number theory and matrices to understand their linkage to the real-world problems. Perform matrix algebra with applications to Computer Graphics.

Course Contents:

List of practical (using any software)

1. Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ----------+ 1/ N.
2. . Enter 100 integers into an array and sort them in an ascending order.
3. Solution of transcendental and algebraic equations by numerical methods.
4. Solution of system of linear equations by numerical methods
5. Numerical illustration of Interpolation
6. Illustration of Numerical Integration
7. Fitting a Polynomial Function.
8. Numerical solution of ordinary differential equations

Note: For any of the CAS (Computer aided software) Data types-simple data types, floating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays should be introduced to the students

Course Learning Outcomes: This course will enable the students to:

1. The main objective of the course is to equip the student to plot the different graph using different computer software such as Mathematica /MATLAB/Maple /Scilab/Maxima etc.

2. The next objective of the course is to solve the different types of equations by plotting the graph using different computer software such as Mathematica /MATLAB/Maple / Scilab/Maxima etc.

3. Student would be Solving the systems of linear equations

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Semester VII
Minor Course IX

Course Name: Differential Geometry	**Course Code:** BSMT 704

Credits = L+T+P (4+1+0)	**Hours (Total) =60**

Course Objectives: The course will enable the students to know about understand role of differential geometry. Learn various properties of curves including Frenet-Serret formulae and their applications. familiarize with Fourier transforms of functions,

Course Contents:

Unit 1
Basic definitions and examples, Arc length, Curvature and the Frenet-Serret formulae, Fundamental existence and uniqueness theorem for curves, Non-unit speed curves.

Unit 2
Basic definitions and examples, The first fundamental form, Arc length of curves on surfaces,
Normal curvature, Geodesic curvature, Gauss and Weingarten formulae, Geodesics, Parallel vector fields along a curve and parallelism.

Unit 3
The second fundamental form and the Weingarten map; Principal, Gauss and mean curvatures; Isometries of surfaces, Gauss's Theorema Egregium, The fundamental theorem of surfaces, Surfaces of constant Gauss curvature, Exponential map, Gauss lemma, Geodesic coordinates, The Gauss-Bonnet formula and theorem..

Course Learning Outcomes: After the course, the student will be able to:

1. application of problem-solving with differential geometry to diverse situations in physics, engineering and in other mathematical contexts.
2. application of this course in real life problems.

Reference Books

1. C. Bär, Elementary Differential Geometry. Cambridge University Press, 2010.

2. M.P. do Carmo, Differential Geometry of Curves & Surfaces, 2nd Ed., Dover Publications, 2016.

3. A. Gray, Modern Differential Geometry of Curves and Surfaces with Mathematica, 4th Ed., Chapman & Hall/CRC Press, Taylor & Francis, 2018.

3. R.S. Millman & G.D. Parkar, Elements of Differential Geometry. Prentice-Hall, 1977

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Semester VIII

Major Course XVI

Course Name: Complex Analysis	**Course Code:** BSMT 801

Credits =L+T+P (4+1+0)	**Hours (Total) =60**

Course Objectives: This course aims to introduce the basic ideas of analysis for complex functions in complex variables with visualization through relevant practical's. Particular emphasis has been laid on Cauchy's theorems, series expansions and calculation of residues.

Course Contents:

Unit 1: Analytic Functions and Cauchy-Riemann Equations

Functions of complex variable, Mappings; Mappings by the exponential function, Limits, Theorems on limits, Limits involving the point at infinity, Continuity, Derivatives, Differentiation formulae, Cauchy-Riemann equations, Sufficient conditions for differentiability; Analytic functions and their examples.

Unit 2: Elementary Functions and Integrals

Exponential function, Logarithmic function, Branches and derivatives of logarithms, Trigonometric

function, Derivatives of functions, Definite integrals of functions, Contours, Contour integrals and its examples, Upper bounds for moduli of contour integrals,

Unit 3: Cauchy's Theorems and Fundamental Theorem of Algebra

Antiderivatives, Proof of antiderivative theorem, Cauchy-Goursat theorem, Cauchy integral formula; An extension of Cauchy integral formula, Consequences of Cauchy integral formula, Liouville's theorem and the fundamental theorem of algebra.

Unit 4: Series and Residues

Convergence of sequences and series, Taylor series and its examples; Laurent series and its examples, Absolute and uniform convergence of power series, Uniqueness of series representations of power series, Isolated singular points, Residues, Cauchy's residue theorem, residue at infinity; Types of isolated singular points, Residues at poles and its examples.

Course Learning Outcomes: The completion of the course will enable the students to:

1. Understand the significance of differentiability of complex functions leading to the understanding of Cauchy-Riemann equations.
2. Evaluate the contour integrals and understand the role of Cauchy-Goursat theorem and the Cauchy integral formula.
3. Expand some simple functions as their Taylor and Laurent series, classify the nature of singularities, find residues and apply Cauchy Residue theorem to evaluate integrals.

Reference:

1. Brown, James Ward, & Churchill, Ruel V. (2014). *Complex Variables and Applications* (9th ed.). McGraw-Hill Education. New York.

Additional Readings:

1. Bak, Joseph & Newman, Donald J. (2010). *Complex analysis* (3rd ed.). Undergraduate Texts in Mathematics, Springer. New York.

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2. Zills, Dennis G., & Shanahan, Patrick D. (2003). *A First Course in Complex Analysis with Applications*. Jones & Bartlett Publishers, Inc.

3. Mathews, John H., & Howell, Rusell W. (2012). *Complex Analysis for Mathematics and Engineering* (6th ed.). Jones & Bartlett Learning. Narosa, Delhi. Indian Edition. (For practicals: Sample materials of files in the form Mathematica/Maple 2011.zip, log to: www.jblearning.com/catalog/9781449604455/).

Semester VIII
Minor Course X

Course Name: Formal Language and Theory of Automata	**Course Code:** BSMT 802

Credits = L+T+P (4+1+0)	**Hours (Total) =60**

Unit 1
Introduction: Alphabets, strings, and languages.

Unit 2
Finite Automata and Regular Languages: deterministic and non-deterministic finite automata, regular expressions, regular languages and their relationship with finite automata, pumping lemma and closure properties of regular languages.

Unit 3
Context Free Grammars and Pushdown Automata: Context free grammars (CFG), parse trees, ambiguities in grammars and languages, pushdown automaton (PDA) and the language accepted by PDA, deterministic PDA, Non- deterministic PDA, properties of context free languages; normal forms, pumping lemma, closure properties, decision properties.

Semester VIII
Research Project/Dissertation

Course Name: Research Project/Dissertation	**Course Code:** BSMT 803R

Credits =L+T+P (12+1+0)	**Hours (Total) =180**

Course Objective: The objective of this course is to develop positive attitude, knowledge and competence for the research in Mathematics.

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2. List of all Courses under different categories for B.Sc.(Research / Honours) Programme

Course Type	Course Code	Course Name
Major Course(MJC)	BSMT-101	Calculus -I
	BSMT-201	Algebra-I
	BSMT-301	Differential Equations
	BSMT-302	Calculus II
	BSMT-401	Modern Algebra
	BSMT-402	Mathematical Methods
	BSMT-403	Mechanics
	BSMT-501	Real Analysis-I
	BSMT-502	Numerical Analysis
	BSMT-503	Metric Spaces
	BSMT-601	Linear Algebra
	BSMT-602	Probability Theory and Statistics
	BSMT-603	Real Analysis-II
	BSMT-701	Probability Theory & Statistics
	BSMT-702	Discrete Mathematics
	BSMT-703	Optimization Technique and Game Theory
	BSMT-801	Complex Analysis
	BSMT-201P	Maths Practical
	BSMT-705P	Mathematical Tools Practical
Minor Course(MIC) of Mathematics Department	BSMT-102	Introduction of Set Theory
	BSMT-202	Matrices and It's Applications
	BSMT-303	Vector Calculus
	BSMT-404	Graph Theory
	BSMT-504	Linear Programming and It's Applications
	BSMT-505	Introductory Probability
	BSMT-604	Theory of Real Functions
	BSMT-605	Statistical Methods
	BSMT-704	Differential Geometry
	BSMT-802	Formal Language and Theory of Automata

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Multidisciplinary Course(MDC) of Mathematics Department	M-DIS-A/B	A. Applied Statistics B. Geometry
	M-DIS-A/B	A. Laplace Transform and It's Applications B. Cryptography and Network Security
	M-DIS-A/B	A. Introduction to Linear Programming B. Introduction to Information Theory and Coding
Skill Enhancement Course (SEC)	SEC-A/B/C(**Any ONE**)	A. Basic Number Theory B. Bio-Mathematics C. Sets and Logic
	SEC-A/B/C(**Any ONE**)	A. Mathematical Finance B. Statistical Techniques for Research Methods C. Introduction to tensor Calculus
	SEC-A/B/C(**Any ONE**)	A. Computer Algebra Systems and Related Software's B. Basic Numerical Methods C. LaTeX and HTML
Ability Enhancement Course(AEC)	AEC-01	English Communication Skill
	AEC-02	Environmental Science
	AEC-03	Disaster Risk Management
	AEC-04	Course on NCC/NSS/NGO'S/Scout Guide's/ Sports
Value Added Course(VAC)	VAC-RB	Rashtra Bodh
	VAC-IKS	Indian Knowledge System (IKS)
INT	BSMT-505I	Internship
RP-1	BSMT-803R	Research Project/ **Dissertation**

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