Master of Science

Mathematics

AY: 2021- 22

Program and Course Structure

School of Basic Science and Research
Department of Mathematics

M. Sc. (Mathematics)

SBR0301

Batch 2021-23

1.1 Vision, Mission and Core Values of the University

Vision of the University

To serve the society by being a global University of higher learning in pursuit of academic excellence, innovation and nurturing entrepreneurship.

Mission of the University

1. Transformative educational experience.
2. Enrichment by educational initiatives that encourage global outlook.
3. Develop research, support disruptive innovations and accelerate Entrepreneurship.
4. Seeking beyond boundaries.

Core Values

1.Integrity
2. Leadership
3.Diversity
4.Community

1.2 Vision and Mission of the School

Vision of the School

Achieving excellence in the realm of science to address the challenges of evolving society.

Mission of the School

1. Equip the students with knowledge and skills
2. Capacity building by providing academic flexibility to student and faculty members
3. To establish centre of excellence for innovative research
4. Address the deficiencies of the society pertaining to environment
5. To strengthen academic- industry collaboration for better employability
6. Developing a culture for continued betterment in all facets of life

Core Values

1.Integrity
2. Leadership
3. Diversity
4. Community

1.3 Vision and Mission Department of Mathematics

Vision of the Department

To become a globally recognized destination for education in applied mathematics and research.

Mission of the Department

1. To develop mathematical skills in students and make them employable across a wide range of professions and promote interest research.
2. To develop entrepreneurial skills in students to serve the society at large.
3. To develop skills for the applications of mathematics in the various fields.

Core Values

1. Integrity
2. Leadership
3. Diversity
4. Community

1.4 Programme Educational Objectives (PEO's)

PEO1: To deliver deep subject knowledge in the courses of study to enable students to shine in various fields such as sciences, engineering and technology, IT etc.
PEO2: To develop positive attitude and skills to enable the students to become a multi facet personality.
PEO3: To prepare students for entrance examinations conducted by IIT's/Universities to pursue Ph. D. programs as well as NET, UGC-CSIR.
PEO4: To develop students to be excellent to be excellent communicators and team players.

1.4.1 Program Outcomes (PO's)

PO1: Mathematical knowledge: Application of Mathematical knowledge in various fields of science, engineering and management etc.
PO2: Nature of Mathematics: Understand the concise, precise and rigorous nature of Mathematics.
PO3: Critical thinking: Develop the skill to think critically on abstract concepts of Mathematics.
PO4: Problem analysis: Develop the ability to analyze a problem logically and dissect into micro-parts and thus resolving the problem to accessible components.
PO5: Mathematical logic and Ethics: Formulates and develops mathematical arguments in logical manner and Realize and understand professional, ethical and cultural responsibilities.

1.4.2 Programme Specific Outcomes (PSO's)

PSO1 : Scientific thinking and logical abilities.
PSO2 : Application of Mathematical principles in practical situations and software developments.
PSO3 : Analyze any problem to micro-levels and solve the problem step by step.
PSO4 : Owning up responsibility for logical comprehension and preparedness for constant improvement.

1.4.2 Mapping of PEOs with Mission Statements:

PEO Statements	School Mission 1	School Mission 2	School Mission 3	School Mission 4	School Mission 5	School Mission 6
PEO1:	3	2	3	1	2	3
PEO2:	3	2	3	1	2	3
PEO3:	3	3	3	3	3	3
PEO4:	3	2	3	1	3	3

1.4.3 Mapping of Program Outcome (PO's)Vs Program Educational Objectives (PEO's)

	PEO1	PEO2	PEO3	PEO4
PO1	3	3	3	2
PO2	3	3	3	2
PO3	3	3	3	2
PO4	3	2	3	2
PO5	2	3	2	3
PSO1	2	2	3	2
PSO2	3	2	2	3
PSO3	3	3	2	3
PSO4	3	2	3	3

1. Slight (Low) ***2. Moderate (Medium)*** ***3. Substantial (High)***

1.3.5 Program Outcome (PO's)Vs Courses Mapping Table:

1.3.5.1 COURSE ARTICULATION MATRIX

Co's	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MMT-101	3	2	2	3	2	3	3	2	2
MMT-102	3	2	2	3	3	3	2	2	2
MMT-104	3	2	2	3	2	3	3	2	2
MMT-105	3	2	2	3	2	3	3	2	2
MMT-129	3	2	2	3	2	3	3	2	2
MMT-151	3	3	2	3	3	3	3	3	3
MMT-152	2	3	2	3	3	2	3	3	3
MMT-123	3	2	2	3	2	3	3	2	2
MMT-106	3	2	3	3	2	3	3	2	2
MMT-107	3	2	2	3	2	3	3	2	2
MMT-108	3	2	3	3	3	3	3	2	2
ENP-601	2	1	1	2	1	1	2	1	1
CCU-401	--	-	-	-	-	-	-	-	-

MMT-153	3	3	2	2	3	3	3	3	3
MMT-154	3	2	3	3	2	3	3	2	3
MMT-201	3	2	2	3	3	3	2	2	2
MMT-205	3	2	2	3	2	3	3	2	2
MMT-209	3	3	3	3	2	3	2	2	2
MMT-204	3	2	2	3	3	3	3	2	2
MMT-206	3	2	2	3	2	3	2	2	2
MMT-221	3	3	2	3	2	3	2	3	3
MMT-222	3	2	3	3	2	3	3	2	3
MMT-250	3	3	2	2	3	3	3	2	3
MMT-261	2	3	2	2	3	3	3	3	2
MMT-202	3	2	2	3	3	3	3	2	2
MMT-203	3	2	2	3	2	3	2	2	2
MMT-208	3	3	2	3	2	3	3	2	2
MMT-210	3	3	2	3	2	3	3	3	2
MMT-262	3	3	2	2	3	3	3	3	3

1-Slight (Low)
2-Moderate (Medium)
3-Substantial (High)

Department of Mathematics
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TERM: I

S. No.	SUBJECT CODE	Title of Paper	Teaching Load				CREDITS	PRE-REQUISITE/ CO-REQUISITE	Type of Course1: 1. CC 2. AECC 3. SEC 4. DSE
	THEORY		**L**	**T**	**P**	**TOTAL**			
1.	MMT 101	REAL ANALYSIS	4	-	-	4	4	**CO-REQUISITE**	CC
2.	MMT 102	LINEAR ALGEBRA	4	-	-	4	4	**CO-REQUISITE**	CC
3.	MMT 105	ORDINARY & PARTIAL DIFFERENTIAL EQUATIONS	4	-	-	4	4	**CO-REQUISITE**	CC
4.	MMT 104	STATISTICAL METHODS	4	-	-	4	4	**CO-REQUISITE**	CC
5.	MMT 129	INTRODUCTION to MATLAB AND ITS APPLICATIONS	3	-	-	3	3	**CO-REQUISITE**	AECC
	PRACTICALS								
6.	MMT 151	MATHEMATICS LAB- I	-	-	3	3	2	**CO-REQUISITE**	AECC
7	MMT 152	MATHEMATICS LAB II	-	-	3	3	2	**CO-REQUISITE**	AECC
TOTAL			**19**	**-**	**6**	**25**	**23**		

[1] CC: Core Course, AECC: Ability Enhancement Compulsory Courses, SEC: Skill Enhancement Courses, DSE: Discipline Specific Courses

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TERM: II

S. No.	SUBJECT CODE	Title of Paper	Teaching Load				CREDITS	PRE-REQUISITE/ CO-REQUISITE	Type of Course[2]: 1. CC 2. AECC 3. SEC 4. DSE
	THEORY		**L**	**T**	**P**	**TOTAL**			
1.	MMT 123	NUMERICAL ANALYSIS WITH MATLAB	4	-	-	4	4	**CO-REQUISITE**	CC
2.	MMT 106	COMPLEX ANALYSIS	4	-	-	4	4	**CO-REQUISITE**	CC
3.	MMT 107	TOPOLOGY	4	-	-	4	4	**CO-REQUISITE**	CC
4.	MMT 108	DIFFERENTIAL GEOMETRY & TENSOR ANALYSIS	4	-	-	4	4	**CO-REQUISITE**	CC
5.	ENP 601	TECHNICAL PRESENTATION	-	-	4	2	2	**CO-REQUISITE**	SEC
6.	CCU 401	COMMUNITY CONNECT COURSE	-	-	2	2	2	**CO-REQUISITE**	SEC
	PRACTICALS								
7.	MMT 153	MATHEMATICS LAB- III	-	-	3	3	2	**CO-REQUISITE**	AECC
8.	MMT 154	MATHEMATICS LAB- IV	-	-	3	3	2	**CO-REQUISITE**	AECC
TOTAL			**16**	**-**	**12**	**26**	**24**		

[2] CC: Core Course, AECC: Ability Enhancement Compulsory Courses, SEC: Skill Enhancement Courses, DSE: Discipline Specific Courses

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TERM: III

S. No.	SUBJECT CODE	Title of Paper	Teaching Load				CREDITS	PRE-REQUISITE/ CO-REQUISITE	Type of Course3: 1. CC 2. AECC 3. SEC 4. DSE
	THEORY		**L**	**T**	**P**	**TOTAL**			
1.	MMT-201	ABSTRACT ALGEBRA	4	-	-	4	4	**CO-REQUISITE**	CC
2	MMT 205	FUNCTIONAL ANALYSIS	4	-	-	4	4	**CO-REQUISITE**	CC
		SPECIALIZATION PAPERS(I&II) (OPT ANY TWO COURSES FROM 3, 4, 5 and any one from 6)							AECC
3. 4. 5. 6..	MMT 209 MMT 204 MMT 206 MMT 221/ MMT 222	GRAPH THEORY AND ITS APPLICATIONS FLUID DYNAMICS NUMBER THEORY WITH CRYPTOGRAPHY APPLICATIONS (E)/ BIG DATA SCIENCE (E)/ MACHINE LEARNING (E)	4+4+3	-	-	11	11	**CO-REQUISITE**	AECC
	PRACTICALS								
7.	MMT 250	MATHEMATICS LAB- V	-	-	3	3	2	**CO-REQUISITE**	AECC
	DISSERTATION								
8.	MMT 261	**DISSERTATION-I** (A topic from specialization papers)	-	-		2	4	**CO-REQUISITE**	AECC
TOTAL			**19**	**-**	**3**	**24**	**25**		

[3] CC: Core Course, AECC: Ability Enhancement Compulsory Courses, SEC: Skill Enhancement Courses, DSE: Discipline Specific Courses

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TERM: IV

S. No.	SUBJECT CODE	Title of Paper	HOURS				CREDITS	PRE-REQUISITE/ CO-REQUISITE	Type of Course4: 1. CC 2. AECC 3. SEC 4. DSE
	THEORY		**L**	**T**	**P**	**TOTAL**			
1.	MMT 202	MEASURE THEORY	4	-	-	4	4	**CO-REQUISITE**	CC
		SPECIALIZATION PAPERS(III&IV) (OPT ANY TWO COURSES FROM 2, 3, 4)							
2. 3. 4. 5. 6.	MMT 203 MMT 208 MMT 210 OPE XXX	LINEAR PROGRAMMING DISCRETE MATHEMATICS WAVELET ANALYSIS AND THEIR APPLICATIONS Open elective (GE)	4+4+2	-	-	10	10	**CO-REQUISITE**	DSC
	PRACTICALS		-	-	-				
	DISSERTATION								
7.	MMT 262	**DISSERTATION-2** (A topic from specialization papers)	-	-		8	6	**CO-REQUISITE**	AECC
TOTAL			**14**	**-**	**-**	**22**	**20**		

[4] CC: Core Course, AECC: Ability Enhancement Compulsory Courses, SEC: Skill Enhancement Courses, DSE: Discipline Specific Courses

COURSE STRUCTURE

Real Analysis (MMT 101)

School: SBSR		**Batch : 2021-23**	
Program: M.Sc.		**Current Academic Year: 2021-22**	
Branch: Mathematics		**Semester: I**	
1	Course Code	MMT 101	
2	Course Title	**Real Analysis**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. The objective of this course is to develop the knowledge of various concepts of Real numbers and their properties. 2. The objective of this course is to develop a deeper and more rigorous understanding of Calculus including defining terms and proving theorems about sequences, series, limits, continuity, derivatives, the Riemann integrals, and sequences of functions.	
6	Course Outcomes	CO1: Explain functions between sets; equivalent sets; finite, countable and uncountable sets and some operations on real numbers. (K2,K4) CO2: Evaluate convergent, divergent, bounded, Cauchy and monotone sequences and series. (K2,K5) CO3: Explain and determine the continuity, discontinuity and uniform continuity of functions. (K2,K3,K4) CO4: Determine the uniform convergence of sequences and series. (K2,K3) CO5: Evaluate convergence and divergence of sequences and series of functions. (K2,K5) CO6: Describe and use the concepts of fundamental theorem of Integral calculus, Riemann Integral and Riemann – Stieltjes integral (K2,K3)	
7	Course Description	This course is an introduction to the fundamentals of Real analysis. This provides the understanding of convergence, divergence, uniform convergence and absolute convergence of sequences and series of Real numbers. It gives an idea about continuity, discontinuity and uniform continuity of functions. It will be helpful in solving Real integrals.	
8	Outline syllabus	Real analysis	CO Mapping
	Unit 1		
	A	Neighbourhoods of a point in Υ, open and closed intervals in Υ, neighbourhoods of points in Υ^2	CO1
	B	limit points of sets, compact sets of R	CO1
	C	Bolzano-Weierstrass theorem, Heine-Borel theorem	CO1
	Unit 2		
	A	Sequence of real numbers, convergence of sequences	CO2

	B	Cauchy sequence, limit superior and limit inferior of sequences	CO2
	C	Series – convergence, tests of convergence, conditional and absolute convergence	CO2
	Unit 3		
	A	Continuous functions, uniform and absolute continuity	CO3
	B	uniform convergence of sequences and series	CO4
	C	Term by term differentiation, power series	CO4
	Unit 4		
	A	Sequences and series of functions, point-wise and uniform convergence, Cauchy criterion for uniform convergence	CO5
	B	Weierstrass M test, Abel's and Dirichlet's test for uniform convergence and differentiation, uniform convergence and integration, Weierstrass approximation theorem	CO5
	C	Power series, uniqueness theorem of power series, Abel's and Taylor's theorem, rearrangement of terms of series, Riemann's theorem	CO5
	Unit 5		
	A	The fundamental theorem of integral calculus, definition of Riemann integral, refinement of partitions, Dorboux's theorem	CO6
	B	Properties and some important theorems on Riemann integral, integration of vector valued functions,	CO6
	C	Riemann – Stieltjes integral, refinement of partitions, properties and some important theorems on Riemann – Stieltjes integration	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA / MTE / ETE 25 Marks / 25 Marks / 50 Marks	
	Text book/s*	1. Jain P. K. and Gupta V. P.: Lebesgue measure and integration, Wiley Eastern Ltd., New Age Int. Ltd., New Delhi, (1994). 2. Rudin W.: Principles of Mathematical Analysis	
	Other References	(i) Malik S. C. and SavitaArora; Mathematical Analysis, second ed., Wiley Eastern Ltd., New Age Int. Ltd., New Delhi, (1994). (ii) Somasundaram D. and Chaudhary B.: A first course of Mathematical Analysis, Narosa publishing house, New Delhi, 1987.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C101.1	3	3	3	3	3	3	3	2	1
C101.2	3	2	3	3	2	3	2	1	1
C101.3	2	2	2	2	2	2	2	1	1
C101.4	2	2	1	2	2	2	3	1	1
C101.5	3	2	2	3	2	3	2	2	2
C101.6	3	2	1	3	2	2	2	1	2

LINEAR ALGEBRA (MMT 102)

School: SBSR		**Batch : 2021-23**
Program: M.Sc.		**Current Academic Year: 2021-22**
Branch: Mathematics		**Semester: I**
1	Course Code	MMT102
2	Course Title	LINEAR ALGEBRA
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. To familiarise students with basic concept of determinants, properties of determinants, rank of a matrix, inverse of a non-singular square Matrix, solution of system of linear equations. Have an idea of the fields and vector spaces, linear transformations, null spaces, rank and nullity theorem, inner products and norms, orthogonal vectors, Cauchy-Schwarz inequality, Orthogonal bases, Gram - Schmidt process. 2. Have an understanding of Characteristic roots of real matrices, right and left characteristic vectors, independence of characteristic vectors corresponding to distinct characteristic roots. To know definiteness of a real quadratic form, simultaneous reduction of two quadratic forms, maxima and minima of ratio of two quadratic forms.

6	Course Outcomes	CO1: Describe the basic concept of determinants, properties of determinants, and solve rank of a matrix, inverse of a non-singular square matrix and evaluate solution of system of linear equations. (K1,K2,K3,K5) CO2: Describe the concept of fields and vector spaces, linear transformations, null spaces, explain rank and nullity theorem. (K1,K2, K4) CO3: Explain the concept of inner products and norms, orthogonal vectors, Cauchy-Schwarz inequality and evaluate orthogonal bases, define Gram - Schmidt process. (K1, K2, K4, K5) CO4: Explain characteristic roots of real matrices, right and left characteristic vectors and evaluate independence of characteristic vectors corresponding to distinct characteristic roots. (K2, K4, K5) CO5: Illustrate generalized inverse of a matrix, left inverse, right inverse and pseudo inverse and compose Spectral decomposition theorem. (K3, K6) CO6: Explain Definiteness of a real quadratic form, simultaneous reduction of two quadratic forms and evaluate maxima and minima of ratio of two quadratic forms. (K2, K4, K5)	
7	Course Description	This course is an introduction to Linear Algebra. The primary objective of the course is to develop the advance understanding of linear algebra.	
8	**Outline syllabus LINEAR ALGEBRA**		**CO Mapping**
	Unit 1	**Review of Matrix Algebra**	
	A	Determinants, properties of determinants	CO1
	B	rank of a matrix, inverse of a non-singular square Matrix	CO1
	C	Solution of system of linear equations.	CO1
	Unit 2	**Vector Spaces**	
	A	Fields and vector spaces, linear transformations, null spaces, rank and nullity theorem,	CO2,
	B	Inner products and norms, orthogonal vectors, Cauchy-Schwarz inequality,	CO2, CO3
	C	Orthogonal bases, Gram - Schmidt process	CO2, CO3
	Unit 3	**Characteristic roots and Characteristic Vectors**	
	A	Characteristic roots of real matrices	CO4
	B	Right and left characteristic vectors,	CO4
	C	Independence of characteristic vectors corresponding to distinct characteristic roots	CO4
	Unit 4	**Generalized Inverse**	
	A	Generalized inverse of a matrix	CO5
	B	Left inverse, right inverse and pseudo inverse	CO5
	C	Applications, Spectral decomposition theorem.	CO5
	Unit 5	**Quadratic Forms**	
	A	Definiteness of a real quadratic form	CO6
	B	Simultaneous reduction of two quadratic forms,	CO6
	C	Maxima and minima of ratio of two quadratic forms.	CO6

	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book/s*	1. Graybill F.A.: Matrix with applications in statistics, 2nd Ed., Wadsworth (1983). 2. Rao C. R. &Mitra S. K. : Generalized inverse of matrices and its application. John Wiley & Sons Inc. (1971)			
	Other References	3. Kenneth Hoffman & Ray Kunze: Linear Algebra, EEE, PHI learning (Indian Ed.), 2012. 4. Hohn F. E.: Elements of Matrix Algebra, Macmillan, (1973). 5. Searle S. R.: Matrix Algebra useful to statistics, John willey& sons 1982.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C102.1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**
C102.2	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**1**	**2**
C102.3	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**
C102.4	**2**	**2**	**1**	**2**	**2**	**2**	**3**	**1**	**2**
C102.5	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**
C102.6	**3**	**2**	**1**	**3**	**3**	**2**	**2**	**1**	**1**

ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS (MMT 105)

School: SBSR		**Batch: 2021-23**	
Program: M. Sc.		**Current Academic Year: 2021-22**	
Branch: Mathematics		**Semester: I**	
1	Course Code	**MMT 105**	
2	Course Title	**ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	• Familiarise students with basic concepts of ordinary and partial differential equations and learn to solve first-order ordinary differential equations and formation of ODEs. • Explore the methods to solve linear differential equation of nth order with constant coefficients and variable coefficients. Students will also master the technique of separation of variables to solve PDEs and able to derive heat and wave equations.	
6	Course Outcomes	**CO1**: Explain and illustrate how to form the ordinary differential equations and solve the equations of first order and first degree. (K2,K3,K4) **CO2:** Describe and solve the linear differential equation of nth order with constant coefficients. (K1, K2, K3) **CO3:**. Explain Cauchy Euler's equations and solve the same, evaluate simultaneous linear differential equations by method of variation of parameters. (K2,K3,K4,K5) **CO4:** Describe the classification of PDEs of second order and evaluate the wave equation by using method of separation of variable. (K1,K2,K5) **CO5:** Evaluate the heat equation in one dimension in various cases. (K5) **CO6:** Explain and then evaluate Laplace equation. (K2, K4, K5)	
7	Course Description	This course is an introduction to ordinary and partial differential equations. The primary objective of the course is to develop the advance understanding of ordinary and partial differential equations.	
8	Outline syllabus		CO Mapping
	Unit 1		
	A	Basics of differential equations including order, degree, type of differential equation and formation of differential equations.	CO1
	B	Equations of first order and first degree including separation of variables, homogeneous and exact differential equations (including integrating factor).	CO1
	C	Linear differential equations. .	CO1

	Unit 2				
	A	Linear differential equation of nth order with constant coefficients, auxiliary equations			CO2
	B	auxiliary equations, complementary functions			CO2
	C	particular integrals for various standard functions and their combinations			CO2
	Unit 3				
	A	Cauchy Euler's equations and equations reducible to homogeneous form			CO3
	B	Simultaneous linear differential equations			CO3
	C	method of variation of parameters			CO3
	Unit 4				
	A	Classification of PDEs of second order, Boundary value problems, the principle of superposition			CO4
	B	method of separation of variables, its application to solve wave equation			CO4
	C	D'Alembert's solution of wave equation in various cases..			CO4
	Unit 5				
	A	Solution of heat equation in one dimension in various cases			CO5
	B	solution of Laplace equation in Cartesian coordinates			CO6
	C	its conversion into polar coordinates.			CO6
	Mode of examination	Theory/Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book/s*	1. Ordinary and Partial Differential equations by M. D. Raisinghania, S Chand and Company Ltd. 2. Schaum's Outline Series of Partial Differential equations 3. Schaum's Outline Series of Ordinary Differential equations .			
	Other References	1. An introduction to Ordinary Differential Equations by Earl. A. Codington, DOVER PUBLICATIONS, INC. New York. 2. Elements of Partial Differential Equations by Ian N. Sneddon, McGRA-HILL Book Company.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C105.1	3	3	3	3	3	3	3	2	1
C105.2	3	2	3	3	2	3	2	1	2
C105.3	2	2	3	2	2	2	3	2	1
C105.4	2	2	1	2	2	2	3	1	2
C105.5	3	2	2	3	2	3	2	2	2
C105.6	3	2	1	3	2	2	2	2	2

STATISTICAL METHODS (MMT 104)

School: SBSR		**Batch: 2021-23**
Program: M. Sc.		**Current Academic Year: 2021-22**
Branch: Mathematics		**Semester: I**
1	Course Code.	MMT104
2	Course Title	STATISTICAL METHODS
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course status	Compulsory
5	Course Objectives	• To familiarise the students how to calculate and apply measures of location and measures of dispersion --grouped and ungrouped data cases and communicate quantitative data verbally, graphically, symbolically and numerically. • To make students familiar with the concept of Probability and Statistics, discrete and continuous probability distributions to various business problems and theory of measure theory and integration of a measurable function with respect to a measure
6	Course	CO1: Describe the overall process and particular steps in designing studies,

	Outcomes	collecting and analyzing data, interpreting and presenting results; Develop skills in presenting quantitative data using appropriate diagrams, tabulations and summaries. (K1, K2, K6) CO2: Explain the basic concepts of probability, random variables, probability distribution, and joint probability distribution and describe the properties of discrete and continuous distribution functions. (K1,K2,K4) CO3: Explain the fundamentals of measure theory and be acquainted with the proofs of the fundamental theorems underlying the theory of integration and illustrate measure theory random variables, independence, expectations and conditional expectations, product measures and discrete parameter martingales. (K2,K3,K4) CO4: Explain the concept of length, area, volume using lebesgue's theory. (K2,K4) CO5: Describe how these underpin the use of Mathematical concepts such as volume, area, and integration and evaluate the same. (K1,K2, K5) CO6: Explain and illustrate the general principles of measure theory and integration in such concrete subjects as the theory of probability. (K2,K3,K4)
7	Course Description	In this course we will explore the use of statistical methodology in designing, analyzing, interpreting, and presenting experiments and observations. We will cover descriptive statistics, probability, discrete random variables, continuous random variables, probability distributions and also learn the basic elements of Measure Theory, with related discussions on applications in probability theory.
8	Outline syllabus:	

UNIT 1	Descriptive Statistics and Probability	CO Mapping
A	Representation of data (measures of central tendency).	CO1
B	Dispersion & other characteristics of data (mean deviation, variance, quartiles, Skewness and Kurtosis, Moments).	CO1
C	probability (elementary theorems, Baye's theorem).	CO1
UNIT 2	Random variable and Probability Distribution	
A	Random variables, expectation, variance, mean, median, mode, moments, moment generating function.	CO2
B	Special discrete & continuous distributions and their mean & variance.	CO2
C	Binomial, poisson, exponential, Gamma, normal, t, Chi-square, F distributions, simple applications.	CO2
UNIT 3	Probability measure	
A	Classes of sets, fields, sigma fields, lim sup, lim inf of sequences of sets.	CO3
B	Measure, probability measure, properties of measure.	CO3
C	Caratheodory extension theorem (only statement), Lebesgue measure.	CO3, CO4
UNIT 4	Measurable functions	
A	Measurable functions, sequence of random variables.	CO3, CO5
B	Almost sure convergence.	CO5,CO6
C	Convergence in probability and measure.	CO5,CO6

UNIT 5	Integration			
A	Integration of a measurable function with respect to a measure.			CO5,CO6
B	Monotone convergence theorem.			CO5,CO6
C	Fatou's lemma, dominated convergence theorem.			CO5,CO6
	Mode of Examination	Theory		
	Weightage distribution	CA	MTE	ETE
		25 Marks	25 Marks	50 Marks
	Text books	1. Gupta,S.C and Kapoor,V.K, "Fundamental of Mathematical Statistics". Sultan Chand & sons.		
	Other references	1. ROBERT A.: Real analysis and probability, Academic Press (1972). 2. BILLINGSLY P.: Probability and measure, Willey (1989). 3. KINGMAN J.-F. C. & TAYLOR S. J.: Introduction to measure and probability, Cambridge university press.		

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C104.1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**
C104.2	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**1**	**2**
C104.3	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**
C104.4	**2**	**2**	**1**	**2**	**2**	**2**	**3**	**1**	**1**
C104.5	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**
C104.6	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**1**	**2**

School: SBSR		**Batch : 2021-23**	
Program: M.Sc.		**Current Academic Year: 2021-22**	
Branch: Mathematics		**Semester: I**	
1	Course Code	MMT-129	
2	**Course Title**	**INTRODUCTION TO MATLAB AND ITS APPLICATIONS**	
3	Credits	**3**	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Compulsory	
5	Course Objective	The goal of this course is to introduce the necessary mathematical concepts for MATLAB and cover the syntax and semantics of MATLAB including control structures, comments, variables, functions etc. Once the foundations of the language have been established students will explore different types of scientific programming problems including curve fitting, ODE solving etc.	
6	Course Outcomes	CO1: Describe the fundamentals of MATLAB and use MATLAB for interactive computations. (K2, K3) CO2: Demonstrate with strings and matrices and their uses. (K2, K3) CO3: Illustrate basic flow controls (if-else, for, while). (K3) CO4: Create plots and export this for use in reports and presentations. (K3, K5) CO5: Develop program scripts and functions using the MATLAB development environment. (K4, K5) CO6: Write the program for evaluates linear system of equations, ordinary differential equations in MATLAB. (K5,K6)	
7	Course Description	The course will give the fundamental knowledge and practical abilities in MATLAB required to effectively utilize this tool in technical numerical computations and visualisation in other courses. Syntax and interactive computations, programming in MATLAB using scripts and functions, rudimentary algebra and analysis. One- and two-dimensional graphical presentations. Examples on engineering applications.	
8	Outline syllabus	**Introduction to MATLAB**	CO Mapping
	Unit 1	**Introduction**	
	A	Vector and matrix generation, Subscripting and the colon notation.	CO1
	B	Matrix and array operations and their manipulations,	CO1
	C	Introduction to some inbuilt functions.	CO1
	Unit 2	**Relational and Logical Operators**	
	A	Flow control using various statement and loops including	CO1, CO3

		If-End statement, If-Else –End statement			
	B	Nested If-Else-End Statement,			CO3
	C	For – End and While-End loops with break commands.			CO3
	Unit 3	**m-files**			
	A	Scripts and functions			CO2,CO5
	B	concept of local and global variable			CO2,CO5
	C	Few examples of in-built functions, editing, saving m-files.			CO2,CO5
	Unit 4	**Two dimensional Graphics**			
	A	Basic Plots, Change in axes and annotation in a figure			CO4
	B	multiple plots in a figure			CO4
	C	saving and printing figures			CO4
	Unit 5	**Applications of MATLAB**			
	A	Solving a linear system of equations,			CO5, CO6
	B	Curve fitting with polynomials using inbuilt function such as polyfit, solving equations in one variable,			CO5, CO6
	C	Solving ordinary differential equations using inbuilt functions			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book	An introduction to MATLAB : Amos Gilat			
	Other References	1. Applied Numerical Methods with Matlab for engineering and Scientists by stevenchapra, Mcgraw Hill. 2. Getting started with Matlab: RudraPratap			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C129.1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**
C129.2	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**1**	**2**
C129.3	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**1**
C129.4	**2**	**2**	**1**	**2**	**2**	**2**	**3**	**1**	**1**
C129.5	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**
C129.6	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**1**	**2**

NUMERICAL ANALYSIS WITH MATLAB (MMT 123)

School: SBSR		**Batch : 2021-23**	
Program: M.Sc.		**Current Academic Year: 2021-22**	
Branch: Mathematics		**Semester: II**	
1	Course Code	MMT-123	
2	Course Title	**NUMERICAL ANALYSIS WITH MATLAB**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	• To provide the student with numerical methods of solving the non-linear equations, interpolation, differentiation, and integration. • To improve the student's skills in numerical methods by using the MATLAB	
6	Course Outcomes	CO1: Calculate the error and evaluate the floating point and develop the algorithm in MATLAB. (K1,K3,K5,K6) CO2: Solve a linear system of equations using an appropriation method and develop the algorithm in MATLAB. (K1,K,K5,K6) CO3: Solve the algebraic or transcendental equations using numerical methods and develop the algorithm in MATLAB. (K1,K3,K5,K6) CO4: Calculate a definite integral using an appropriation method and develop the algorithm in MATLAB. (K1,K3,K5,K6) CO5: Derivations and stability analysis for Taylor series method. CO6: Evaluate differential equation by Euler's method and its variants, Runge- Kutta second order and fourth order methods and develop the algorithm in MATLAB. (K1,K3,K5,K6)	
7	Course Description	This course is an introduction to the numerical analysis. The primary objective of the course is to develop the basic understanding of numerical algorithms and skills to implement algorithms to solve mathematical problems in MATLAB.	
8	Outline syllabus		CO Mapping
	Unit 1	**Error Analysis:**	
	A	Definition and sources of errors, Propagation of errors	CO1
	B	Sensitivity and conditioning, Stability and accuracy,	CO1
	C	Floating-point arithmetic and rounding errors.	CO1
	Unit 2	**Solution of system of linear equations:**	
	A	Direct methods: Cramer's rule, Matrix inverse method,	CO2

	B	Gauss elimination and Gauss-Jordan method			CO2
	C	Iterative methods: Jacobi's method, Gauss-Seidal method			CO2
	Unit 3	**System of Transcendental equations**			
	A	Initial approximation of the roots, Bisection method,			CO3
	B	Method of false position, secant method, iteration method			CO3
	C	Newton-Raphson method and its convergence.			CO3
	Unit 4	**Numerical differentiation and integration:**			
	A	Differentiation using Newton's forward and backward formula			CO4
	B	Newton-Cotes quadrature formula - derivations			CO4
	C	Comparison of Trapezoidal rule, Simpson's 1/3 and 3/8 rules.			CO4
	Unit 5	**Initial value Problems**			
	A	Single-step methods: General definitions and Lipschitz condition, Derivations and stability analysis for Taylor series method,			CO5
	B	Euler's method and its variants, Runge- Kutta second order and fourth order methods;			CO6
	C	Implementation of these methods for various test problems using MATLAB			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book/s*	1) An Introduction to Numerical Analysis by EndreSuli, David F. Mayers, Cambridge University Press, 2003. 2) Applied Numerical Analysis by C. F. Gerald, Pearson Education, 2009. 3) Elements of Numerical Analysis by R. S. Gupta, Macmillan India Ltd, 2009.			
	Other References	1) Numerical methods in Engineering & Science by B. S. Grewal, Khanna Publishers, 2013. 2) Numerical methods for Scientific and Engineering Computation by Jain, Iyengar, Jain, New Age International Publishers, 2004.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C123.1	3	3	3	3	3	3	3	2	1
C123.2	3	2	3	3	2	3	2	1	1
C123.3	2	2	2	3	2	2	2	2	2
C123.4	2	2	2	3	2	2	3	1	1
C123.5	3	2	2	3	2	3	2	2	2
C123.6	3	2	1	3	2	2	2	1	2

Complex Analysis (MMT 106)

School: SBSR		**Batch : 2021-23**
Program: M.Sc.		**Current Academic Year: 2021-22**
Branch: Mathematics		**Semester: II**
1	Course Code	MMT-106
2	Course Title	Complex Analysis
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	• This course is aimed to provide an introduction to the theories for functions of a complex variable. The concepts of analyticity, Cauchy-Riemann relations and harmonic functions, Complex integration and complex power series are presented. Discuss the classification of isolated singularities and examine the theory and illustrate the applications of the calculus of residues in the evaluation of integrals. • Students will study geometric properties of conformal mappings in the plane and their relations with analytic functions

6	Course Outcomes	CO1: Discuss the concept of complex number and its algebra calculates continuity, differentiability, analyticity of a function and analyse the derivative of a function. (K2,K3, K4) CO2: Describe the concept of analytic function and check the analyticity of the functions. (K3, K6) CO 3: Explain the concept of harmonic function and evaluate harmonic conjugates and discuss about series and their convergence, power series, radius of convergence. (K2, K4,K5) CO 4: Illustrate the concept of complex integration, write the Green's theorem, anti-derivative theorem, Cauchy-Goursat theorem, Cauchy's integral formula, Liouville theorem, Morera's theorem and evaluate derivative of analytic functions. (K3, K5,K6) CO 5: Discuss the concept of singularities and its types; write Taylor and Laurent series, Cauchy's residue theorem, evaluate the definite integrals using Cauchy's residue theorem.(K1,K2,K5,K6) CO6: Demonstrate the understanding of conformal mappings and Construct conformal mappings between many kinds of domain. (K2, K5)	
7	Course Description	This course is an introduce the theories for functions of a complex variable. The concepts of analyticity, Cauchy-Riemann relations and harmonic functions, Complex integration and complex power series are presented. Discuss the classification of isolated singularities and examine the theory and illustrate the applications of the calculus of residues in the evaluation of integrals.	
8	Outline syllabus		CO Mapping
	Unit 1		
	A	Complex numbers, their representation in Argand's plane and the algebra of complex numbers,	CO1
	B	The complex plane and open set, domain and region in a complex plane	CO1
	C	Complex functions and their limits, continuity, differentiability.	CO1
	Unit 2		
	A	Analytic function, The C-R equations and sufficient conditions for differentiability and analyticity	CO2
	B	Harmonic functions and harmonic conjugates, Sequences,	CO3
	C	Series and their convergence, power series, radius of convergence.	CO3
	Unit 3		
	A	Complex integration: Line integration, path independence,	CO4
	B	Green's theorem, anti-derivative theorem, Cauchy-Goursat theorem, Cauchy's integral formula,	CO4
	C	Derivative of analytic functions, Liouville theorem, Morera's theorem.	CO4

	Unit 4				
	A	Singularities and its types; Taylor and Laurent series			CO5
	B	Cauchy's residue theorem,			CO5
	C	Evaluation of definite integrals using Cauchy's residue theorem.			CO5
	Unit 5				
	A	Transformations or mappings, some standard transformations,			CO6
	B	Bilinear transformation, fixed point of a transformation,			CO6
	C	Conformal transformation, jacobian of a transformation and few special conformal mappings			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book/s*	1) Churchill, Ruel V. and Brown, JamesWard, Complex Variables and Applications, fourth edition, McGraw-Hill Book Co., New York, 1984. 2) Conway, John B., Functions of One Complex Variable, II, Graduate Texts inMathematics, 159, Springer-Verlag, New York, 1995.			
	Other References	1) Schaum's Outline of Complex Variables, 2ed by By Murray Spiegel, Seymour Lipschutz, John Schiller, Dennis Spellman 2) Ahlfors, Lars V., Complex Analysis: An Introduction to the Theory of Analytic Functions of One Complex Variable, third edition. International Series in Pure and Applied Mathematics, McGraw-Hill Book Co., New York, 1978.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / **CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
C106.1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**

C106.2	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**1**	**1**
C106.3	**2**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**2**
C106.4	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**1**	**1**
C106.5	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**
C106.6	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**1**	**2**

TOPOLOGY (MMT 107)

School: SBSR		**Batch : 2021-23**
Program: M.Sc.		**Current Academic Year: 2021-22**
Branch: Mathematics		**Semester: II**
1	Course Code	MMT 107
2	Course Title	TOPOLOGY
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	This course provides an introduction to topics involving concepts of Topological space and separate axioms (Hausdorff space and base problems),Compactness (Urysohn's theorem), Connectedness With Nets(converge filter Zorn's lemma).
6	Course Outcomes	**CO1:** Explain the concept of Topological spaces and calculate interior, exterior limit point and boundary points. (K2, K3, K4) **CO2:** Describe the concept of separate axioms and evaluate T_0, T_1, T_2 spaces, normal and completely normal spaces. (K1,K2, K5) **CO3:** Discuss the compactness (Urysohn's theorem) and evaluate cover, open cover, finite sub cover, compact sets. (K1, K2, K5) **CO4:** Explain Lindeloff space, locally compact, Map: continuous function and write Heine borel theorem, describe homeomorphism, open and closed map, compactness for continuous images. (K2,K4,K6) **CO5:** Explain about separated sets, disconnectedness, totally disconnectedness, maximal connected set and illustrate component and path, locally connected and write Urysohn's theorem. (K2, K3, K4, K6) **CO6:** Describe the concept of Nets and Filters and write zorn's lemma. (K1,K2, K6)
7	Course Description	This course provides an introduction to topics involving concepts of Topological space and separate axioms (Hausdorff space and base problems), Compactness (Urysohn's theorem), Connectedness With Nets (converge filter Zorn's lemma). The primary objective of the course is to develop the advance understanding of Topology.

8	Outline syllabus				CO Mapping
	Unit 1	**Topological space**			
	A	Topology, weaker and stronger topology, indiscrete and discrete topology			CO1
	B	Co-finite and usual topology, interior, exterior			CO1
	C	limit point and boundary points.			CO1
	Unit 2	**Separation axioms**			
	A	Base, sub-base and countability (first countable and second countable)			CO2
	B	separation axioms: T_0, T_1, T_2 spaces, normal and completely normal spaces			CO2
	C	regular and completely regular spaces, T_3, T_4 and Tychnoff space, Hausdorff space and based problems			CO2
	Unit 3	**Compactness**			
	A	Cover, open cover, finite sub cover, compact sets, finite intersection property			CO3
	B	Heine borel theorem, Lindeloff space, locally compact, Map: continuous function			CO3, CO4
	C	homeomorphism, open and closed map, compactness for continuous images			CO3, CO4
	Unit 4	**Connectedness**			
	A	Separated sets, disconnectedness, totally disconnectedness, maximal connected set			CO5
	B	component and path, locally connected and based examples			CO5
	C	Urysohn's theorem (proof).			CO5
	Unit 5	**Nets**			
	A	Binary relation, Directed set, residual subset, sequence convergence of a set			CO6
	B	cluster point, subnet. **Filters:** Filter, Cofinite filter, neighbourhood filter, filter base			CO6
	C	convergent filter and Zorn's lemma			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book/s*	1. S. Kumaresan, Topology of Metric Spaces, 2nd Ed., Narosa Publishing House, 2011. 2. Dugundji, James, Topology, Allyn and Bacon Series in Advanced Mathematics, Allyn and Bacon, Inc., Boston, Mass.-London-Sydney, 1978.			
	Other References	1. Munkres, James R, Topology: A First Course, Prentice-Hall, Inc., Englewood			

		Cli_s, N.J., 1975. 2. Kelley, John L., General Topology, Graduate Texts in Mathematics, No. 27, Springer-Verlag, New York-Berlin, 1975.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C107.1	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**1**
C107.2	**3**	**2**	**3**	**3**	**3**	**3**	**2**	**1**	**2**
C107.3	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**1**	**1**
C107.4	**2**	**2**	**1**	**2**	**2**	**2**	**3**	**1**	**1**
C107.5	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**
C107.6	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**1**	**2**

DIFFERENTIAL GEOMETRY & TENSOR ANALYSIS (MMT 108)

School: SBSR		**Batch: 2021-23**
Program: M. Sc.		**Current Academic Year: 2021-22**
Branch: Mathematics		**Semester: II**
1	Course Code	**MMT 108**
2	Course Title	**DIFFERENTIAL GEOMETRY & TENSOR ANALYSIS**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. Familiarise students with basic concept of local theory of curves: space curves, e.g., plane curves, tangent and normal and binormal; Osculating plane, normal lines and normal plane, curvature and torsion, rectifying plane; Helices, arc length, Serret-Frenet formulae. Have an idea of Bertrand curves and its properties, Contact between curve and surfaces, tangent surfaces, tangent vectors and vector fields, Fundamental theorems for

		space curves, involutes and evolutes of curves, Metric-first fundamental form and second fundamental form. 2. Have an understanding of Normal curvature, quadratic form of normal curvature, mean curvature, Gaussian curvature and minimal surface, geodesics, canonical geodesic equations, normal properties of geodesics, geodesics curvature, lines of curvature, Rodrigue's formula. Know about Tensor calculus, Vector spaces, the dual spaces, tensor product of vector spaces, transformation formulae, contraction, inner product and outer product of two tensor. To know Contra variant and covariant tensors, mixed tensors of higher order, symmetric and skew-symmetric tensors, Quotient theorem, Reciprocal tensors, metric tensor, conjugate metric tensor with examples. Christoffel's symbols, covariant differentiation and Riemannian curvature tensor.	
6	Course Outcomes	CO1: Describe the concept of local theory of curves: space curves, Osculating plane, normal lines and normal plane and explain curvature and torsion rectifying plane; Helices, arc length, Serret-Frenet formulae. (K1,K2,K4) CO2: Explain the theory of curves: Bertrand curves, Contact between curve and surfaces, tangent surfaces, tangent vectors and vector fields and write Fundamental theorems for space curves, involutes and evolutes of curves describe Metric-first fundamental form and second fundamental form. (K2,K4,K6) CO3: Discuss the concept of curvature and evaluate normal curvature, quadratic form of normal curvature, mean curvature, Gaussian curvature and minimal surface, geodesics, canonical geodesic equations, normal properties of geodesics, geodesics curvature, lines of curvature, Rodrigue's formula. (K1,K2,K5) CO4: Explain Tensor calculus, Vector spaces, and the dual spaces, tensor product of vector spaces, transformation formulae, and contraction; evaluate inner product and outer product of two tensor. (K2,K4,K5) CO5: Describe the concept of contra variant and covariant tensors, mixed tensors of higher order, symmetric and skew-symmetric tensors. (K1,K2) CO6: Write the Quotient theorem, Reciprocal tensors, metric tensor, illustrate conjugate metric tensor with examples. Christoffel's symbols, covariant differentiation and Riemannian curvature tensor.(K3,K6)	
7	Course Description	This course is an introduction to differential geometry and tensor analysis. The primary objective of the course is to develop the advance understanding of differential geometry and tensor analysis.	
8	Outline syllabus		CO Mapping
	Unit 1	**Review of local theory of curves**	
	A	Space curves, e.g., plane curves, tangent and normal and binormal	CO1
	B	Osculating plane, normal lines and normal plane, curvature and torsion	CO1
	C	Rectifying plane; Helices, arc length, Serret-Frenet formulae.	CO1
	Unit 2	**Theory of Curves**	
	A	Bertrand curves and its properties, Contact between curve and surfaces, tangent surfaces, tangent vectors and vector fields	CO2
	B	Fundamental theorems for space curves, involutes and evolutes of curves	CO2
	C	Metric-first fundamental form and second fundamental form.	CO2

	Unit 3	**Curvature**			
	A	Normal curvature, quadratic form of normal curvature, mean curvature			CO3
	B	Gaussian curvature and minimal surface, geodesics, canonical geodesic equations			CO3
	C	Normal properties of geodesics, geodesics curvature, lines of curvature, Rodrigue's formula			CO3
	Unit 4	**Tensor calculus**			
	A	Tensor calculus, Vector spaces, the dual spaces			CO4
	B	Tensor product of vector spaces, transformation formulae, contraction			CO4
	C	Inner product and outer product of two tensor			CO4
	Unit 5	**Contra variant and covariant tensors**			
	A	Contra variant and covariant tensors, mixed tensors of higher order, symmetric and skew-symmetric tensors			CO5
	B	Quotient theorem, Reciprocal tensors, metric tensor, conjugate metric tensor with examples			CO6
	C	Christoffel's symbols, covariant differentiation and Riemannian curvature tensor.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book/s*	1. Elementary Differential Geometry, Revised 2nd Edition, by Barrett O'Neill 2. Differential Geometry by J.J Stoker, John Wiley and Sons.			
	Other References	1. Schaum's Outline Series of Differential Geometry			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C108.1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**
C108.2	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**1**	**2**
C108.3	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**1**

C108.4	**2**	**2**	**1**	**2**	**2**	**2**	**3**	**1**	**2**
C108.5	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**
C108.6	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**1**	**2**

Community Connect (CCU 401)

<table>
<tr><td colspan="2">SCHOOL: School of Basic Sciences and Research</td><td colspan="2">TEACHING DEPARTMENT: Community Connect</td><td colspan="2">ACADEMIC SESSION : 2021-23</td><td>FOR STUDENTS BATCH – M.Sc. 2021-22</td></tr>
<tr><td>1</td><td>Course Number</td><td colspan="5">Course Code: CCU401/ Course ID: 30804</td></tr>
<tr><td>2</td><td>Course Title</td><td colspan="5">Community Connect</td></tr>
<tr><td>3</td><td>Credits</td><td colspan="5">2</td></tr>
<tr><td>3.01</td><td>(L-T-P)</td><td colspan="5">(00-00-02)</td></tr>
<tr><td>4</td><td>Learning Hours</td><td colspan="5"><table><tr><td>Contact Hours</td><td>30</td></tr><tr><td>Project/Field Work</td><td>20</td></tr><tr><td>Assessment</td><td>00</td></tr><tr><td>Guided Study</td><td>10</td></tr><tr><td>Total hours</td><td>60</td></tr></table></td></tr>
<tr><td>5</td><td>Course Objectives</td><td colspan="5">1. To expose our students to different social issues faced by the people in different sections of society.
2. To connect their class-room learning with problem solving skills in real life scenario.</td></tr>
<tr><td>6</td><td>Course Outcomes</td><td colspan="5">After completion of this course students will be able to:
1. Recognise social problems prevailing in different sections of society and finding the solution in sustainable manner.
2. Get practical exposure of all round development which complements their class room learning
3. These activities will add value to students, faculty members, school and university.</td></tr>
<tr><td>7</td><td>Theme</td><td colspan="5">Major themes for research:

1. Survey and self-learning: In this mode, students will make survey, analyse data and will extract results out of it to correlate with their theoretical knowledge. E.g. Crops and animals, land holding, labour problems, medical problems of animals and humans, savage and sanitation situation, waste management etc.
2. Survey and solution providing: In this mode, students will identify the common problems and will provide solution/ educate rural population.</td></tr>
</table>

		E.g. air and water pollution, need of after treatment, use of renewable (mainly solar) energy, electricity saving devices, inefficiencies in cropping system, animal husbandry, poultry, pest control, irrigation, machining in agriculture etc. 3. ***Survey and reporting***: In this mode students will educate villagers and survey the ground level status of various government schemes meant for rural development. The analysed results will be reported to concerned agencies which will help them for taking necessary/corrective measures. E.g. Pradhan Mantri Jan Dhan Yojana, Pradhan Mantri MUDRA Yojana, Pradhan Mantri Jeevan Jyoti Bima Yojana, Atal pension Yojana, Pradhan Mantri Awas Yojana, Pradhan Mantri FasalBima Yojana, Swachh Bharat Abhiyan, Soil Health Card Scheme, Digital India, Skill India Program, Beti Bachao, Beti Padhao Yojana, DeenDayal Upadhyaya Gram Jyoti Yojana, Shyama Prasad Mukherjee Rurban Mission, UJWAL Discom Assurance Yojana, PAHAL,Pradhan Mantri Awas Yojana-Gramin, Pradhan Mantri Yuva Yojana, Pradhan Mantri Jan Aushadhi Yojana, Pradhan Mantri KhanijKshetra Kalyan Yojana, Pradhan Mantri Suraksha Bima Yojana, UDAN scheme, DeenDayal Upadhyaya Grameen Kaushalya Yojana, Pradhan Mantri Sukanya Samriddhi Yojana, Sansad Adarsh Gram Yojana, Pradhan Mantri SurakshitMatritva Abhiyan, Pradhan Mantri RojgarProtsahan Yojana, Midday Meal Scheme, Pradhan Mantri Vaya Vandana Yojana, Pradhan Mantri Matritva Vandana Yojana, and Ayushman Bharat Yojana.
8.1	**<u>Guidelines for Faculty Members</u>**	It will be a group assignment. There should be not more than 10 students in each group. The faculty guide will guide the students and approve the project title and help the student in preparing the questionnaire and final report. The questionnaire should be well design and it should carry at least 20 questions (Including demographic questions). The faculty will guide the student to prepare the PPT. The topic of the research should be related to social, economical or environmental issues concerning the common man. The report should contain 2,500 to 3,000 words and relevant charts, tables and photographs. The student should **submit the report** to CCC-Coordinator signed by the faculty guide by 15 April 2019. The students have to send the hard copy of the **report and PPT**, and then only they will be allowed for ETE.
8.2	**Role of CCC-Coordinator**	The CCC Coordinator will supervise the whole process and assign students to faculty members. 1. PG-M.Sc.-Semester II – the students will be allocated to faculty member (mentors/faculty member) in even term.

		2. UG- B.Sc.-Semester III - the students will be allocated to faculty member (mentors/faculty member) in odd term.
8.3	**Layout of the Report**	Abstract(250 words) a. Introduction b. Literature review(optional) c. Objective of the research d. Research Methodology e. Finding and discussion f. Conclusion and recommendation g. References Note: Research report should base on primary data.
8.4	**Guideline for Report Writing**	**Title Page: The following elements must be included:** • Title of the article; • Name(s) and initial(s) of author(s), preferably with first names spelled out; • Affiliation(s) of author(s); • Name of the faculty guide and Co-guide **Abstract:** Each article is to be preceded by a succinct abstract, of up to 250 words, that highlights the objectives, methods, results, and conclusions of the paper. **Text:Manuscripts should be submitted in Word.** • Use a normal, plain font (e.g., 12-point Times Roman) for text. • Use italics for emphasis. • *Use the automatic page numbering function to number the pages.* • *Save your file in docx format* (Word 2007 or higher) or doc format (older Word versions) **Reference list:** The list of references should only include works that are cited in the text and that have been published or accepted for publication. The entries in the list should be in alphabetical order. Journal article Hamburger, C.: Quasimonotonicity, regularity and duality for nonlinear systems of partial differential equations. Ann. Mat. Pura Appl. 169, 321–354 (1995) Article by DOI Sajti, C.L., Georgio, S., Khodorkovsky, V., Marine, W.: New nanohybrid materials for biophotonics. Appl. Phys. A (2007). doi:10.1007/s00339-007-4137-z Book Geddes, K.O., Czapor, S.R., Labahn, G.: Algorithms for Computer Algebra. Kluwer, Boston (1992) Book chapter Broy, M.: Software engineering — from auxiliary to key technologies. In: Broy, M., Denert, E. (eds.) Software Pioneers, pp. 10–13. Springer, Heidelberg (2002) Online document

		Cartwright, J.: Big stars have weather too. IOP Publishing PhysicsWeb. http://physicsweb.org/articles/news/11/6/16/1 (2007). Accessed 26 June 2007 Always use the standard abbreviation of a journal's name according to the ISSN List of Title Word Abbreviations, see www.issn.org/2-22661-LTWA-online.php For authors using EndNote, Springer provides an output style that supports the formatting of in-text citations and reference list. EndNote style (zip, 2 kB) **Tables:All tables are to be numbered using Arabic numerals.** **Figure Numbering:All figures are to be numbered using Arabic numerals**. The soft copy of final report should be submitted by email to Dr. Piali Haldar(piali.haldar@sharda.ac.in)within 16th **April2019 along with hard copy signed by faculty guide.**
8.5	**Format:**	**The report should be Spiral/ hardbound** The Design of the Cover page to report will be given by the Coordinator- CCC Coverpage Acknowledgement Content Project report Appendices

Technical Presentation (ENP 601)

School: SBSR		**Batch: 2021-23**
Program: M. Sc.		**Current Academic Year: 2021-22**
Branch: Mathematics		**Semester: II**
1	Course Code	ENP 601
2	Course Title	Technical Presentation
3	Credits	2
4	Contact Hours (L-T-P)	0-0-4
	Course Status	Compulsory
5	Course Objective	To make effective presentations and to develop a range of writing processes appropriate to various writing tasks. Observe appropriate generic conventions and formats for technical documents.
6	Course Outcomes	CO1: Describe the concept how to write effective reports and effective proposals. CO2: Explain the how to implement the basics of Presentation. Practise the general guidelines of technical presentation. Practise use of graphics in data presentation. . CO3: Discuss how to prepare effective technical documentation. Practise various research techniques using internet.

		CO4: Demonstrate the structure and content of synopsis and dissertation. CO5: Describe how to write bibliographies. CO6: Write various kinds of business letters and emails effectively. Practice oral presentation skills through public speaking and oral presentation of reports. Present a research topic effectively			
7	Course Description				
8	Outline syllabus				CO Mapping
	Unit 1	Technical Documentation			
	A	Report Writing			CO1
	B	Writing proposals			CO1
	C	Studying Samples of Reports and Proposals			CO1
	Unit 2	Technical Presentation			
	A	General Guidelines for Technical Presentation			CO2
	B	Creating PowerPoint Presentation			CO2
	C	Presenting Data using Graphics			CO2
	Unit 3	Research Documentation			
	A	Research Techniques using library and internet			CO3
	B	Inputs on Dissertation and writing a Synopsis			CO3
	C	Writing Bibliographies			CO3
	Unit 4	Professional Communication			
	A	Writing Formal Business Letters			CO4
	B	Writing Formal E-mails			CO4
	C	Case Study			CO4
	Unit 5	Oral Presentation Skills			
	A	Public Speaking- Practical			CO5
	B	Tips on presenting a Research Topic			CO6
	C	Oral Presentation of Reports			CO6
	Mode of examination	Practical			
	Weightage Distribution	CA	Viva	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book/s*	Pearsall, Thomas E.; Cook, Kelli Cargile, Elements of Technical Writing. Longman, 2009.			
	Other References	1. Steve Mandel. Presentation skills by Steve Mandel 2. Gerson, J. Sharon & Gerson, M. Steven, Technical Writing : Process and Product, Pearson Education, Third Impression 2009.			

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C601.1	1	1	2	1	1	1	2	1	1
C601.2	1	1	1	2	1	2	1	1	1
C601.3	1	2	1	1	1	2	1	1	1
C601.4	1	1	1	1	2	1	1	1	2
C601.5	1	1	2	1	1	1	1	1	1
C601.6	2	1	1	1	1	1	2	1	1

ABSTRACT ALGEBRA (MMT 201)

School: SBSR		**Batch: 2021-23**
Program: M. Sc.		**Current Academic Year: 2021-22**
Branch: Mathematics		**Semester: III**
1	Course Code.	MMT-201
2	Course Title	**ABSTRACT ALGEBRA**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course status	Compulsory
5	Course Objective	1. To familiarise students with basic concepts of group, subgroup, quotient group and permutation groups, and given an idea of the normal subgroup, sylow groups, internal and external direct product. 2. To make students familiar with the concept of homomorphism, isomorphism, automorphism and inner- automorphism, different algebraic structures ring, integral domain, field, ideal and quotient ring, prime and maximal ideal, Irreducible polynomials, principal ideal domains and unique factorization domains. Know about Extension of fields: algebraic extensions, roots of polynomials and splitting fields.
6	Course Outcomes	CO1: Explain and illustrate the concept of group, subgroup, quotient group and permutation groups.(K2,K3,K4) CO2: Describe the Quotient groups, Homomorphism & Isomorphism of groups and evaluate automorphisms, Conjugate elements and Class equations.. (K1,K2,K5) CO3: Explain the concepts of Sylow p – subgroups and analysis Normal and subnormal series. (K2,K4) CO4: Discuss about ring integral domain, field ideal and quotient ring, prime

		and maximal ideal. (K2) CO5: Evaluate irreducible polynomials, principal ideal domains and unique factorization domains. (K5) CO6: Explain about Extension of fields: algebraic extensions and evaluate roots of polynomials and splitting fields. (K2,K4,K5)	
7	Course Description	This course is an introduction to concept of groups, normal subgroups. The primary objective of the course is to develop the understanding of rings and fields.	
8	Outline syllabus		CO Mapping
	Unit 1	**Review of Groups**	
	A	Definition and example of groups, subgroups, cyclic groups,	CO1
	B	Cosets and Lagrange's theorem and the result about its converse. Normal subgroups	CO1
	C	factor groups and applications. Internal and external direct products.	CO1
	Unit 2	**Homomorphism & Isomorphism of groups**	
	A	Quotient groups, Definition and examples of homomorphism, properties of homomorphism,	CO2
	B	Definition and examples of isomorphism, the fundamental theorems of isomorphism, permutation group,	CO2
	C	Cayley's theorem, automorphism, inner automorphisms. Conjugate elements and Class equations.	CO2
	Unit 3	**Sylow Theorems:**	
	A	Sylow p – subgroups, Sylow theorems and applications, Cauchy's Theorem, finitely generated Abelian groups.	CO3
	B	Normal and subnormal series, Composition Series, Jordan-Holder theorem(statement without proof),	CO3
	C	Solvable groups, Nilpotent groups.	CO3
	Unit 4	**Ring Theory**	
	A	Definition and examples of Rings, Integral Domains and Fields: Ideal and quotient Rings.	CO4
	B	Prime and maximal ideals, polynomial rings, irreducible polynomials.	CO4, CO5
	C	Eisenstein criterion, principal ideal domains and unique factorization domains.	CO4, CO5
	Unit 5	**Finite Fields & Galois Theory:**	
	A	Normal extensions, Perfect fields, finite fields, algebraically closed fields, Automorphisms of extensions,	CO6
	B	Galois extensions, Fundamental theorem of Galois theory. Solution of polynomial equations by radicals.	CO6
	C	Isolvability of the general equation of degree 5 by radicals.	CO6
	Mode of	Theory	

	examination				
	Weightage Distribution	CA	MTE	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book/s*	1. Joseph Gallian, contemporary Abstract algebra, seventh edition USA. 2. P. B. Bhatacharya, S. K. Jain and S. R. Nagpal, Basic Abstract Algebra (2nd Edition) Cambridge University Press, Indian Edition, 1977.			
	Other References	1. I. N. Herstain, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975. 2. N. Jacobson, Basic Algebra, Vol I & II, W.H. Freeman, 1980 (also published by Hindustan Publishing Company). 3. V. K. Khanna and S. K. Bhamri, A course in abstract Algebra, 3rd.Ed. 2008. 4. N.S. Gopalakrishnan: University Algebra.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C201.1	3	3	3	3	3	3	3	2	1
C201.2	3	2	3	3	2	3	2	1	2
C201.3	2	2	2	3	3	2	2	1	1
C201.4	2	2	2	3	2	2	3	2	2
C201.5	3	2	2	3	2	3	2	2	2
C201.6	3	2	1	3	2	2	2	1	2

FUNCTIONAL ANALYSIS (MMT 205)

School: SBSR		**Batch : 2021-23**	
Program: M.Sc.		**Current Academic Year: 2022-23**	
Branch: Mathematics		**Semester: III**	
1	Course Code	MMT 205	
2	Course Title	**FUNCTIONAL ANALYSIS**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	To familiarise students with basic concepts of Functional analysis and given an idea of implemented the concepts of Elementary understanding of Normed linear spaces. Can perform basic Bounded linear operator and Know how to calculate system of Inner product spaces. Understand the basic concept of functional analysis and learn basic definitions and terminology associated with to functional analysis.	
6	Course Outcomes	CO1: Describe the basics of functional analysis, normed linear spaces, Holder's inequality, Minkowski's inequality and explain l^p-spaces, equivalence of norms and calculate banach spaces. (K2, K3, K4) CO2: Explain bounded linear spaces, finite dimensional normed space and compactness and evaluate dual of normed spaces $\Re^n$; l^p also of C[a, b]). (K2,K4,K5) CO3: Discuss the concept of open mapping and closed graph theorems, explain uniform boundedness principle and its applications.(K1,K2,K4) CO4: Write Hahn-Banach theorem and its consequence. (K6) CO5: Illustrate Inner product spaces, Hilbert spaces with examples and write Projection theorem, Bessel's inequality, existence of complete orthonormal basis of a Hilbert space Riesz representation theorem. (K3,K6) CO6: Describe the concept of bounded linear functional, Hilbert adjoint operator, self adjoint operator, Compact operators and write Riesz-Schauder theorem. (K1,K2,K6)	
7	Course Description	The primary objective of the course is to develop the understanding the normed linear spaces, bounded linear operator, open mapping and closed graph theorems and Inner product spaces.	
8	Outline syllabus		CO Mapping
	Unit 1	**Normed linear spaces**	
	A	Normed linear spaces, Holder's inequality, Minkowski's	CO1

		inequality			
	B	l^p-spaces, equivalence of norms, equivalence of norms on a finite dimensional space, Riesz lemma,			CO1
	C	Banach spaces, examples			CO1
	Unit 2	**Bounded linear operator**			
	A	Bounded linear operator, spaces of bounded linear operator			CO2
	B	Finite dimensional normed space and compactness			CO2
	C	Dual of normed spaces $\Re^n$; l^p also of C[a, b]).			CO2
	Unit 3	**Open mapping**			
	A	Open mapping and closed graph theorems			CO3
	B	Uniform boundedness principle and its applications			CO3
	C	Hahn-Banach theorem and its consequence.			CO3, CO4
	Unit 4	**Inner product spaces**			
	A	Inner product spaces, Hilbert spaces and examples			CO5
	B	Projection theorem, Bessel's inequality, existence of complete orthonormal basis of a Hilbert space			CO5
	C	Riesz representation theorem			CO5
	Unit 5	**Bounded linear functional**			
	A	Bounded linear functional.			CO6
	B	Hilbert adjoint operator, self adjoint operator, Compact operators			CO6
	C	Riesz-Schauder theorem, self-adjoint compact operators.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book/s*	[1] Kreyszig, Erwin, Introductory Functional Analysis with Applications, Wiley Classics Library, John Wiley & Sons, Inc., New York, 1989. [2] Limaye, Balmohan V., Functional Analysis, second edition, New Age International Publishers Limited,			
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C205.1	3	3	3	3	3	3	3	2	2
C205.2	3	2	3	3	2	3	3	1	1
C205.3	2	2	2	2	2	2	2	2	2
C205.4	2	2	1	2	3	2	3	1	1
C205.5	3	2	2	3	2	3	2	2	2
C205.6	3	2	1	3	2	2	2	1	2

Graph Theory and its Application (MMT 209)

School: SBSR		**Batch : 2021-23**
Program: M.Sc.		**Current Academic Year: 2022-23**
Branch: Mathematics		**Semester: III**
1	Course Code	MMT-209
2	**Course Title**	**Graph Theory and its Application**
3	Credits	**4**
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	The goal of this course is to introduce the necessary mathematical concepts of relevant vocabulary from graph theory and combinatory, and know the statements and proofs of many of the important theorems in the subject, and be able to perform related calculations.
6	Course Outcomes	CO1: Describe the basic concept of graphs and evaluate distances, radius, diameter, centre of a graph, the number of distinct spanning trees in a complete graph. (K2,K4,K5) CO2: Explain the concept of tree and write Kruskal and Prim algorithms, Huffman's algorithm. (K2,K4,K6) CO3: Discuss about matching of graphs and write the theorems related to matching. (K1,K2,K6) CO4: Describe graph colouring, chromatic number, bounds on chromatic numbers and write Greedy algorithm. (K2,K6) CO5: Discuss interval graphs and chordal graphs, chromatic polynomials and write Brook's theorem. (K1, K2, K6)

		CO6: Explain Hamilton property, Non-Hamiltonian graphs, Non-planarity of K5 and K3,3, classification of regular polytopes and write 5-colour theorem. Ramsey theory. (K2,K4,K6)	
7	Course Description	This course covers the theory of graphs and networks for both directed and undirected graphs. Topics include graph isomorphism, Eulerian and Hamiltonian graphs, matching, covers, connectivity, coloring, and planarity. There is an emphasis on applications to real world problems and on graph algorithms such as those for spanning trees, shortest paths, and network flows.	
8	Outline syllabus	**Graph Theory and its Application**	CO Mapping
	Unit 1	**Basic Concepts**.	
	A	Various kinds of graphs, simple graphs, complete graph, walk, tour, path and cycle, Eulerian graph, bipartite graph (characterization).	CO1
	B	Havel-Hakimi theorem and Erdos-Gallai theorem (statement only), hypercube graph, Petersen graph, trees, forests and spanning subgraphs.	CO1
	C	Distances, radius, diameter, center of a graph, the number of distinct spanning trees in a complete graph.	CO1
	Unit 2	**Trees:**	
	A	Kruskal and Prim algorithms with proofs of correctness, Dijkstra'sa algorithm,	CO2
	B	Breadth first and Depth first search trees	CO2
	C	Rooted and binary trees, Huffman's algorithm.	CO2
	Unit 3	**Matching:**	
	A	Augmenting path, Hall's matching theorem, vertex and edge cover, independence number and their connections, Tutte's theorem for the existence of a 1-factor in a graph.	CO3
	B	Connectivity k-vertex and edge connectivity, blocks, characterizations of 2- connected graphs, Menger'stheorem and applications	CO3
	C	Network flows, Ford- Fulkerson algorithm, Supply-demand theorem and the Gale-Ryser theorem on degree sequences of bipartite graphs.	CO3
	Unit 4	**Graph Colourings:**	
	A	chromatic number, Greedy algorithm, bounds on chromatic numbers	CO4
	B	interval graphs and chordal graphs (with simplicial elimination ordering),	CO5
	C	Brook's theorem and graphs with no triangles but large chromatic number, chromatic polynomials.	CO5
	Unit 5	**Hamilton property:**	
	A	Necessary conditions, Theorems of Dirac and Ore,	CO6

		Chvatal's theorem and toughness of a graph.			
	B	Non-Hamiltonian graphs with large vertex degrees. Planar graphs Embedding a graph on plane, Euler's formula.			CO6
	C	Non-planarity of K5 and K3,3, classification of regular polytopes, Kuratowski's theorem (no proof), 5-colour theorem. Ramsey theory.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book	1. B. West, Introduction to Graph Theory, Prentice Hall of India, 2001.			
	Other References	1. J. A. Bondy and U. S. R. Murty, Graph Theory with Applications, Springer-Verlag, 2008. 2. R. Diestel, Introduction to Graph Theory, Springer-Verlag, 2010.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C209.1	3	3	3	3	3	3	3	2	1
C209.2	3	2	3	3	2	3	2	1	2
C209.3	2	2	3	2	3	2	2	1	2
C209.4	2	3	2	2	2	2	3	3	2
C209.5	3	2	2	3	2	3	2	2	2
C209.6	3	2	2	3	2	2	2	2	2

FLUID DYNAMICS (MMT 204)

School: SBSR	**Batch : 2021-23**
Program: M.Sc.	**Current Academic Year: 2022-23**

Branch: Mathematics		Semester: III	
1	Course Code	MMT-204	
2	**Course Title**	**FLUID DYNAMICS**	
3	Credits	**4**	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	The goal of this course is to introduce the necessary mathematical concepts for analysing fluid dynamics. Learn to perform integral analyses and overall balances from conservation laws and differential equations analyses for fields. Understand modelling approximations such as inviscid, incompressible, and turbulent for different types of flows.	
6	Course Outcomes	CO1: Explain the definition, properties and classification of fluid; define Pascal's law and write basic hydrostatic equation, Buoyancy and Archimedes' principle. (K1, K2,K4,K6) CO2: Describe the streamlines, path lines and streak lines, steady/unsteady, uniform/non-uniform, one-two dimensional flows and evaluate velocity and acceleration in an Eulerian flow field. (K1,K2,K5) CO3: Explain equations for stream function, velocity potential function in rectangular and cylindrical co-ordinates and discuss the concept of equations for source, sink, irrotational vortex, circulation.(K1,K2,K4) CO4: Explain and apply Integral equations for the control volume: using Reynold's Transport theorem. (K2,K3,K4) CO5: Explain equations for conservation of mass, energy and momentum and write Bernoulli's equation and its application. (K2,K4,K6) CO6: Apply Mass conservation in 2 dimension in rectangular co-ordinates, Euler's equations in 2,3 dimensions and subsequent derivation of Bernoulli's equation and write Navier-Stokes equations.(K3,K4,K6)	
7	Course Description	This course is an introduction to basics concept of velocity field, fluid statics, basic conservation laws for systems and control volumes, dimensional analysis and similitude, Euler and Bernoulli equations, NavierStokes equations, viscous flows, boundary-layer flow in channels and around submerged bodies, applications.	
8	Outline syllabus	**FLUID DYNAMICS**	CO Mapping
	Unit 1		
	A	Fluid Definition and properties, Newton's law of viscosity concept of continuum, Classification of fluids.	CO1
	B	Definition of body and surface forces, Pascal's law, Basic hydrostatic equation,	CO1
	C	Forces on surfaces due to hydrostatic pressure, Buoyancy and Archimedes' principle.	CO1
	Unit 2		
	A	Eulerian and Lagrangian approach to solutions;	CO2

		Velocity and acceleration in an Eulerian flow field;			
	B	Definition of streamlines, path lines and streak lines; Definition of steady/unsteady, uniform/non-uniform, one-two dimensional flows;			CO2
	C	Definition of control volume and control surface, Understanding of differential and integral methods of analysis			CO2
	Unit 3				
	A	Definition and equations for stream function, velocity potential function in rectangular and cylindrical co-ordinates			CO3
	B	Rotational and irrotational flows;			CO3
	C	Definition and equations for source, sink, irrotational vortex, circulation.			CO3
	Unit 4				
	A	Integral equations for the control volume: Reynold's Transport theorem (without proof),			CO4
	B	Equations for conservation of mass, energy and momentum,			CO5
	C	Bernoulli's equation and its application			CO5
	Unit 5				
	A	Differential equations for the control volume: Mass conservation in 2 dimension in rectangular co-ordinates,			CO6
	B	Euler's equations in 2,3 dimensions and subsequent derivation of Bernoulli's equation;			CO6
	C	Navier-Stokes equations (without proof) in rectangular Cartesian co-ordinates			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book	1. Fluid Mechanics : Streeter and Wylie, McGraw Hill			
	Other References	1. Fluid Mechanics : F.M.White, McGraw Hill 2. Fluid Dynamics, M. D. Raisinghania, S Chand Group			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C204.1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**
C204.2	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**1**	**2**

C204.3	**2**	**3**	**2**	**2**	**3**	**2**	**2**	**1**	**2**
C204.4	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**2**	**1**
C204.5	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**
C204.6	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**

Number Theory with Cryptography (MMT 206)

School: SBSR		**Batch : 2021-23**
Program: M.Sc.		**Current Academic Year: 2022-23**
Branch: Mathematics		**Semester: III**
1	Course Code	MMT 206
2	Course Title	Number Theory with Cryptography
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	To make students familiar with the basic concepts of number theory, congruence. Also students are able to understand public & private key cryptography.
6	Course Outcomes	CO1: Explain the basic concepts of number theory and calculate GCD, LCM; write factorization theorem, Euclid theorem, and Prime number theorem. (K2,K3,K4,K6) CO2: Discuss about congruences along with solutions, residue system, write Fermat's little theorem, Wilson theorem, Chinese remainder theorem, Hansel lemma and calculate Primitive roots. (K1,K2,K5,K6) CO3: Describe classical encryption techniques, Substitution ciphers and transposition ciphers, modern block ciphers principles, public & private key cryptography, write RSA algorithm. (K2,K6) CO4: Discuss and write Gauss lemma, Legendre symbol, quadrqtic reciprocity law, Jacobi symbol.(K2,K6) CO5: Explain the greatest integer function, Euler's totient function, the number of divisors function.(K2,K4) CO6: Discuss and evaluate the sum of divisors function, Mobius mu function, Mobius inversion formula. (K1,K2,K5)
7	Course Description	This course is an introduction to basics of number theory with

		cryptography, congruences, quadratic residues, some standard arithmetic functions.	
8	Outline syllabus : **Number theory with Cryptography (MMT-206)**		CO Mapping
	Unit 1	**BASICS**	
	A	Primes, Divisibility, Euclid's algorithm, GCD, LCM, expressing.	CO1
	B	GCD as a linear combination of the numbers, Unique factorization theorem, Euclid's theorem on infinitude of primes.	CO1
	C	Idea of existence of large gaps between primes, Statement of prime number theorem.	CO1
	Unit 2	**CONGRUENCES**	
	A	Definition, Residue system modulo m, Fermat's little theorem, Euler's generalization of Fermat's theorem.	CO2
	B	Wilson's theorem, Solution of congruences, Chinese remainder theorem.	CO2
	C	Hansel's lemma, Prime power moduli, Primitive roots.	CO2
	Unit 3	**CRYPTOGRAPHY**	
	A	Classical encryption techniques, Substitution ciphers and transposition ciphers, Modern block ciphers and Block ciphers principles.	CO3
	B	Public key Cryptography: Public keys , Encrypting the message.	CO3
	C	Private keys, decrypting and retrieval of the original message (RSA algorithm).	CO3
	Unit 4	**QUADRATIC RESIDUES**	
	A	Gauss lemma.	CO4
	B	Legendre symbol, Jacobi symbol.	CO4
	C	Quadratic reciprocity law.	CO4
	Unit 5	**SOME STANDARD ARITHMETIC FUNCTIONS**	

	A	The greatest integer function, Euler's totient function.			CO5
	B	The number of divisors function, The sum of divisors function.			CO6
	C	Mobius mu function, Mobius inversion formula.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book/s*	• Ivan Niven , Herbert S. Zuckerman , Hugh L. Montgomery: An Introduction to the theory of numbers , John Wiley and Sons (Asia) Pvt. Ltd.			
	Other References	G. H. Hardy & E. M. Wright : An Introduction to the theory of Numbers.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C206.1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**
C206.2	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**1**	**1**
C206.3	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**2**
C206.4	**2**	**2**	**1**	**2**	**2**	**2**	**3**	**1**	**1**
C206.5	**3**	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**2**
C206.6	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**1**	**2**

MEASURE THEORY (MMT 202)

School: SBSR	**Batch : 2021-23**
Program: B.SC	**Current Academic Year: 2022-23**
Branch:	**Semester: IV**

Mathematics			
1	Course Code	MMT 202	
2	Course Title	MEASURE THEORY	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	This course provides an introduction to topics involving concepts of Topological space, σ-algebra of measurable sets, Borel sets, measurable functions, Lebesgue measure, integration of complex functions and linear functional.	
6	Course Outcomes	**CO1:** Explain the concept of Topological spaces and calculate interior, exterior limit point and boundary points. (K2, K3, K4) **CO2:** Describe the concept of approximation of measurable functions, explain Lebesgue's monotone convergence theorem and Fatou's lemma and evaluate integration of positive functions, term by term differentiation of a series of positive measurable functions. (K1,K2, K5) **CO3:** Discuss the integration of complex function.(K1, K2) **CO4:** Explain Lebesgue's dominated convergence theorem, role of sets of measure zero, write extension of a measure to a complete measure. (K2,K4,K6) **CO5:** Explain integration as linear functional, Topological ingredients and write positive Borel measure, Hausdorff spaces. (K2, K3, K4, K6) **CO6:** Describe the concept locally compact Hausdorff spaces, support of a complex function, vector space of continuous complex functions with compact support and write Urysohn's lemma, Riesz representation theorem. (K1,K2, K6)	
7	Course Description	This course provides an introduction to topics involving concepts of Topological space and separate axioms, σ-algebra of measurable sets, Borel sets, measurable functions, Lebesgue measure, integration of complex functions and linear functional. The primary objective of the course is to develop the advance understanding of Measure Theory.	
8	Outline syllabus		CO Mapping
	Unit 1	Preliminaries:	
	A	Topological spaces, continuous functions	CO1
	B	σ-algebra of measurable sets, Borel sets, measurable functions	CO1
	C	lim sup and liminf of sequence of functions.	CO1
	Unit 2	Lebesgue measure:	
	A	Approximation of measurable functions by simple functions, positive measures	CO2
	B	Integration of positive functions, Lebesgue's monotone convergence theorem	CO2
	C	Term by term differentiation of a series of positive	CO2

		measurable functions, Fatou's lemma.	
	Unit 3	**Integration of complex functions:**	
	A	Complex measurable functions, integration of Complex measurable functions	CO3
	B	Lebesgue's dominated convergence theorem , role of sets of measure zero	CO3, CO4
	C	Extension of a measure to a complete measure.	CO3, CO4
	Unit 4	**Integration as a linear functional:**	
	A	Positive Borel measure, vector spaces	CO5
	B	Integration as a linear functional, Topological ingredients	CO5
	C	Definition of compactness and Hausdorff spaces.	CO5
	Unit 5	Riesz representation theorem:	
	A	Locally compact Hausdorff spaces, support of a complex function	CO6
	B	Vector space of continuous complex functions with compact support	CO6
	C	Urysohn's lemma, Riesz representation theorem.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA: 25 Marks; MTE: 25 Marks; ETE: 50 Marks	
	Text book/s*	1) Walter Rudin: Real and Complex analysis, Mc GRAW HILL, International student edition.	
	Other References	1) Walter Rudin: Real and Complex analysis, Mc GRAW HILL, International student edition. 2) Walter Rudin: Principles of Mathematical analysis, Mc GRAW HILL, International series in Pure and Applies Mathematics. H. L. Royden: Real Analysis, Amazon. Com.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C202.1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**
C202.2	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**1**	**1**
C202.3	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**1**
C202.4	**2**	**2**	**1**	**2**	**2**	**2**	**3**	**1**	**1**
C202.5	**3**	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**2**
C202.6	**3**	**2**	**1**	**3**	**2**	**3**	**2**	**2**	**2**

LINEAR PROGRAMMING (MMT 203)

School: SBSR		**Batch : 2021-23**	
Program: M.Sc.		**Current Academic Year: 2022-23**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	MMT 203	
2	Course Title	LINEAR PROGRAMMING	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	To make students familiar with the concepts of simple analytical Methods to solve L.P.P., queuing theory with kendall's notations, inventory control with ABC analysis, Project Management (CPM & PERT).	
6	Course Outcomes	CO1: Discuss the origins of Operation Research, formulate the problems in L.P. and solve it by graphical. (K1, K3, K6) CO2: Explain analytical Methods: Simplex, Big M, Primal and Dual problems and discuss about economic interpretation of dual. (K2,K3, K4) CO3: Describe queuing theory and Kendall's Notations and formulate M/M/1:∞/FCFS model illustrate with example. (K2, K3, K6) CO4: Explain inventory classifications and develop economic order quantity models. (K2, K4, K6) CO5: Explain ABC analysis. (K2,K4) CO6: Describe the concept of CPM and PERT and calculate float calculation and Cost reduction by Crashing of activities. (K1, K2,K3)	
7	Course Description	This course is an introduction to concept of linear programming problems. The primary objective of the course is to develop the understanding of queuing theory with kendall's notations, inventory control with ABC analysis, Project Management (CPM & PERT).	
8	Outline syllabus		CO Mapping
	Unit 1	**Origin of Operation Research**	
	A	Origin of Operation Research, Historical Standpoint, Methodology, Different Phases.	CO1
	B	Characteristics, Scope and Application of Operations Research. Introduction.	CO1
	C	Requirement of LP, Basic Assumptions, Formulation of LP, General Statement of LP, Solution techniques of LP: Graphical Methods.	CO1
	Unit 2	**Analytical Methods**	

	A	Analytical Methods: Simplex.			CO2
	B	Big M, Primal and Dual Problems.			CO2
	C	Economic Interpretation and Dual Simplex Method.			CO2
	Unit 3	**Queuing Theory**			
	A	Basis of Queuing theory, elements of queuing theory.			CO3
	B	Kendall's Notation, Operating characteristics of a queuing system, Classification of Queuing models.			CO3
	C	Preliminary examples of M/M/1:∞/FCFS.			CO3
	Unit 4	**Inventory Control**			
	A	Inventory classification, Different cost associated to Inventory.			CO4
	B	Economic order quantity, Inventory models with deterministic demands			CO4
	C	ABC analysis.			CO4, CO5
	Unit 5	**Project Management**			
	A	Introduction to PERT and CPM, critical Path calculation.			CO6
	B	Float calculation and its importance.			CO6
	C	Cost reduction by Crashing of activity.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book/s*	1. Taha, H.A., Operations Research-An introduction, New York: MacMillan, 1992. 2. KantiSwarup, P. K. Gupta and Man Mohan: Operation Research ; S. Chand & Sons, New delhi.			
	Other References	1. Hadley, G., Linear Programming, Addison –Wesley, 1962. 2. Hillier, F.S. and G.J. Lieberman, Introduction to Operations Research-concept and cases, Asian Ed., Tata McGraw-Hill.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C203.1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**
C203.2	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**1**	**2**
C203.3	**2**	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**1**
C203.4	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**1**	**1**

C203.5	**3**	**1**	**2**	**3**	**2**	**3**	**2**	**2**	**2**
C203.6	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**1**	**1**

DISCRETE MATHEMATICS (MMT 208)

School: SBSR		**Batch : 2021-23**
Program: M.Sc.		**Current Academic Year: 2022-23**
Branch: Mathematics		**Semester: IV**
1	Course Code	MMT-208
2	Course Title	DISCRETE MATHEMATICS
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	This course is aimed to provide an advance understanding to the sets and propositions, relations and functions, permutation and combination, graphs, groups and rings.
6	Course Outcomes	CO1: Discuss the concept of sets, un-countably infinite sets, principle of inclusion and exclusion, multisets, propositions, conditional propositions and evaluate normal forms, Mathematical induction.(K2,K3, K4,K5) CO2: Describe the concept functions, composition of function, invertible functions, discrete properties of binary relations and check the closure of relations. (K3, K6) CO 3: Explain the concept of POSET and lattices, Warshall's algorithm, Equivalence relations and partitions and evaluate Chains, and Anti-chains. Generating Functions, Recurrence relations and discuss linear recurrence relations with constant coefficient, homogeneous solution, total solutions, solutions by method of Generating function. (K2, K4,K5) CO 4: Illustrate the concept permutations and combinations: rule of sum and product, write the algorithms for generation of permutations and combination. (K3, K5,K6) CO 5: Discuss the concept graph, sub-graph, Walks, Path and circuits, Connected graphs, Disconnected graphs and component, evaluate the fundamental circuits, distance, diameters, radius and pendant vertices, rooted and binary trees (K1,K2,K5,K6) CO6: Demonstrate the understanding of Algebraic systems, Group and evaluate Semi-groups, Monoid, Subgroups, Isomorphism and Automorphism. (K2, K5)
7	Course Description	This course is given the deep knowledge of sets and propositions, relations and functions, permutation and combination, graphs, groups and rings.

8	Outline syllabus				CO Mapping
	Unit 1	**Sets and Propositions:**			
	A	Sets, Un-countably infinite sets, Principle of inclusion and exclusion, multisets, propositions, conditional propositions.			CO1
	B	Logical connectivity, Propositional, calculus, Universal and existential quantifiers			CO1
	C	Normal forms, methods of proofs, Mathematical induction.			CO1
	Unit 2	**Relations and Functions:**			
	A	Functions , Composition of function , invertible functions, Discrete properties of binary relations, closure of relations			CO2
	B	Warshall's algorithm, Equivalence relations and partitions, POSET and lattices, Chains, and Anti-chains. Generating Functions, Recurrence relations			CO3
	C	Linear Recurrence relations with constant coefficient, Homogeneous solution, Total Solutions, Solutions by method of Generating function.			CO3
	Unit 3	**Permutation and Combination:**			
	A	Permutations and combinations : Rule of sum and Product			CO4
	B	Permutations, Combination			CO4
	C	Algorithms for Generation of Permutations and Combination.			CO4
	Unit 4	**Graphs:**			
	A	Graph, Sub-graph, Various examples of graph and their subgraphs, Walks, Path and circuits, Connected graphs, Disconnected graphs and componant			CO5
	B	Euler's graphs, various operation on graphs, Hamiltonian Paths and circuits. Trees and fundamental circuits, distance, diameters, radius and pendant vertices, rooted and binary trees			CO5
	C	Counting tree, Spanning tree, Fundamental circuits, Finding all spanning trees, Fundamental circuits.			CO5
	Unit 5	**Groups and Rings:**			
	A	Algebraic systems, Group			CO6
	B	Semi-groups, Monoid, Subgroups			CO6
	C	Isomorphism and Automorphism.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book/s*	1. Liu C.L. and Mohapatra, D.P., " Elements of Discrete Mathematics" , SiE edition, TMH, 2008			

	Other References	1) Kenneth H.R.,' Discrete Mathematics and its Applications", Mc-graw hill. 2) Biggs N., "Discrete Mathematics", 3rd edition, Oxford University	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C208.1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**
C208.2	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**1**	**2**
C208.3	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**1**
C208.4	**2**	**2**	**1**	**2**	**2**	**2**	**3**	**2**	**2**
C208.5	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**
C208.6	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**1**	**2**

Big Data Analytics (MMT 221)

School: SBSR		**Batch : 2021-23**
Program: M.Sc.		**Current Academic Year: 2022-23**
Branch: Mathematics		**Semester: IV**
1	Course Code	MMT-221
2	Course Title	**Big Data Analytics**
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Status	Compulsory
5	Course Objective	This course is aimed to provide an advance understanding to the big data overview, model building, clustering and advance analytics.
6	Course Outcomes	CO1: Discuss the concept big data analysis and data preparation. (K2,K5) CO2: Describe the concept model building, communicating results and check the basic data analysis. (K3, K6) CO 3: Explain the concept how using R to look at data introduction to R , Analysing and Exploring the Data, Statistics for Model Building

		and Evaluation Advanced Analytics. (K2, K4,K5) CO 4: Illustrate the concept of K Means Clustering, association rules, linear regression, logistic regression, Naïve Bayesian Classifier and evaluate decision trees, time series analysis, text analysis. (K3, K5,K6) CO 5: Discuss the concept of unstructured data – Map Reduce and Hadoop, The Hadoop Ecosystem In-database Analytics and illustrate SQL Essentials, Advanced SQL and MADlib for In-database Analytics. (K1,K2,K5,K6) CO6: Demonstrate the understanding of the Endgame, or putting it all together: operationalizing an analytics project, creating the final deliverables, data visualization techniques, final lab exercise on big data analytics. (K2, K5)	
7	Course Description	This course is given the deep knowledge of big data, model building, clustering and advance analytics.	
8	Outline syllabus		CO Mapping
	Unit 1		
	A	State of the Practice in Analytics, the Data Scientist,	CO1
	B	Big Data Analytics in Industry Verticals	CO1
	C	Data Analytics Life cycle: Discovery, Data Preparation, Model Planning.	CO1
	Unit 2		
	A	Model Building, Communicating Results, Operationalizing Review of Basic Data Analytic Methods Using R:	CO2
	B	Using R to Look at Data Introduction to R ,	CO3
	C	Analyzing and Exploring the Data, Statistics for Model Building and Evaluation Advanced Analytics.	CO3
	Unit 3		
	A	K Means Clustering, Association Rules, Linear Regression,	CO4
	B	Logistic Regression, Naïve Bayesian Classifier,	CO4
	C	Decision Trees Time Series Analysis, Text Analysis.	CO4
	Unit 4		
	A	Technologies and Tools : Analytics for Unstructured Data – Map Reduce and Hadoop ,	CO5
	B	The Hadoop Ecosystem In-database Analytics – SQL Essentials	CO5
	C	Advanced SQL and MADlib for In-database Analytics	CO5
	Unit 5		
	A	The Endgame, or Putting it All Together: Operationalizing an Analytics Project,	CO6
	B	Creating the Final Deliverables, Data Visualization Techniques,	CO6

	C	Final Lab Exercise on Big Data Analytics.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book/s*	1) Big Data, Big Dupe, 2016			
	Other References	1) Big Data, Big Dupe, 2016			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C221.1	3	3	3	3	3	3	3	2	2
C221.2	3	2	3	3	2	3	2	2	2
C221.3	2	3	2	3	2	2	2	2	2
C221.4	2	2	2	2	2	2	3	2	2
C221.5	3	2	2	3	2	3	2	2	2
C221.6	3	2	2	3	2	2	2	2	2

Machine Learning (MMT 222)

School: SBSR		**Batch : 2021-23**
Program: M.Sc.		**Current Academic Year: 2022-23**
Branch: Mathematics		**Semester: IV**
1	Course Code	MMT 222
2	Course Title	**Machine Learning**
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Status	Compulsory
5	Course Objective	To make students familiar with the concepts of machine learning, supervised learning, testing and generalization the data
6	Course Outcomes	CO1: Discuss the origins of machine learning and explain supervised, unsupervised, semi-supervised. (K1, K3, K4)

		CO2: Explain and discuss training, validation, testing, generalization, over-ttin.. (K2,K3, K4) CO3: Describe decision trees, random forests. linear classifiers and illustrate with example. (K2, K3, K6) CO4: Explain kernel based methods and SVMs. Nearest neighbour method and develop hidden Markov models. (K2, K4, K6) CO5: Discuss neural and deep networks. (K2,K4) CO6: Explain ensemble methods - boosting, bagging, voting schemes. Illustrate distance metrics and clustering. Methods for semi-supervised learning. (K1, K2,K3)			
7	Course Description	This course is an introduction to concept of linear programming problems. The primary objective of the course is to develop the understanding of queuing theory with kendall's notations, inventory control with ABC analysis, Project Management (CPM & PERT).			
8	Outline syllabus				CO Mapping
	Unit 1				
	A	Machine learning - what, how, where.			CO1
	B	Supervised, unsupervised			CO1
	C	Semi - supervised learning.			CO1
	Unit 2				
	A	Training, validation,			CO2
	B	Testing, generalization, over-tting.			CO2
	C	Features and feature engineering.			CO2
	Unit 3				
	A	Decision trees,			CO3
	B	Random forests			CO3
	C	Linear classifiers.			CO3
	Unit 4				
	A	Kernel based methods and SVMs.			CO4
	B	Nearest neighbour methods.			CO4
	C	Hidden Markov models. Neural and deep networks.			CO4, CO5
	Unit 5				
	A	Ensemble methods - boosting, bagging, voting schemes.			CO6
	B	Distance metrics and clustering			CO6
	C	Methods for semi-supervised learning.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book/s*	Bishop, C. (2006). Pattern Recognition and Machine Learning. Berlin: Springer-Verlag			
	Other References	Bishop, C. (2006). Pattern Recognition and Machine Learning. Berlin: Springer-Verlag			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C222.1	3	3	3	3	3	3	3	2	2
C222.2	3	2	3	3	2	3	2	1	2
C222.3	2	2	2	2	2	2	2	2	1
C222.4	2	2	2	3	2	2	3	1	2
C222.5	3	1	2	3	2	3	2	2	2
C222.6	3	2	1	3	2	2	2	2	2

Practical Courses

Mathematics Lab I (MMT 151)

School: SBSR	Batch: 2021-23

Program: M.Sc.		Current Academic Year: 2021-22	
Branch: Mathematics		**Semester: I**	
1	Course Code	MMT-151	
2	Course Title	Mathematics Lab I	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-3	
	Course Status	Compulsory	
5	Course Objective	The goal of this course is to introduce students to the fundamental mathematical concepts for MATLAB. The course will cover the syntax and semantics of MATLAB including control structures, comments, variables, functions etc. Once the foundations of the language have been established students will explore different types of scientific programming problems including curve fitting, ODE solving etc	
6	Course Outcomes	CO1: Describe the fundamentals of MATLAB and use MATLAB for interactive computations. (K2, K3) CO2: Demonstrate with strings and matrices and their uses. (K2, K3) CO3: Illustrate basic flow controls (if-else, for, while). (K3) CO4: Create plots and export this for use in reports and presentations. (K3, K5) CO5: Develop program scripts and functions using the MATLAB development environment. (K4, K5)	
7	Course Description	The course will give the fundamental knowledge and practical abilities in MATLAB required to effectively utilize this tool in technical numerical computations and visualisation in other courses. Syntax and interactive computations, programming in MATLAB using scripts and functions, rudimentary algebra and analysis. One- and two-dimensional graphical presentations. Examples on engineering applications.	
8	Outline syllabus		CO Mapping
	Unit 1	**Practical based** MATLAB as a calculator.	**CO1**
		Creating an Array in MATLAB	CO1
	Unit 2	**Practical related to** -- Mathematical Operations with Arrays	**CO3**
	Unit 3	**Practical related to**--- How to make scripts files in MATLAB and do some examples.	**CO5**
	Unit 4	**Practical related to**--- Make some function files in MATLAB. Basic two-dimensional and three-dimensional plotting, change in axes and annotation in a figure.	**CO4,CO5**
	Unit 5	**Practical related to**--- If-End statement, If-Else-End statement, nested If-Else-End statement	**CO2,CO5**

		Solving a system of linear equations, curve fitting with polynomials using inbuilt functions such as polyfit.			
	Mode of examination	Practical &Viva			
	Weightage Distribution	CA	Viva	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book	1. An introduction to MATLAB : Amos Gilat			
	Other References	1. Applied Numerical Methods with Matlab for engineering and Scientists by stevenchapra, Mcgraw Hill. 2. Getting started with Matlab: RudraPratap			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C151.1	3	3	2	2	2	3	2	2	3
C151.2	2	3	3	3	3	2	3	3	2
C151.3	2	3	2	2	3	3	3	3	3
C151.4	2	3	2	3	2	2	2	3	2
C151.5	3	3	2	3	2	2	3	2	3

Mathematics Lab I MMT 152 (Practical)

School: SBSR		**Batch: 2021-23**
Program: B.Sc.(H)		**Current Academic Year: 2021-22**
Branch: Mathematics		**Semester: I**
1	Course Code	MMT 152
2	Course Title	Mathematics Lab II
3	Credits	2
4	Contact Hours (L-T-P)	0-0-3
	Course Status	Compulsory
5	Course Objective	To familiarize the student in introducing and exploring MS excel. To enable the student on how to approach for solving statistical problems using excel tools.

		To prepare the students to use excel in their project works. To provide a foundation in use of this MS office for real time applications.			
6	Course Outcomes	CO1: Understand the procedures,Analyzing and Visualizing Data with Excel. (K2) CO2: Discuss and develop the basic understanding of creating formulas and how cells are referenced by rows and columns within Excel. (K2, K5, K6) CO3: Discuss and construct table and graph of data with excel. (K2, K5, K6) CO4: Discuss and calculate basic statistical parameters (mean, measures of dispersion, correlation coefficient, indexes). (K2, K5, K6) CO5: Discuss and calculate correlationbetween two variables with excel. (K2, K5, K6) CO6: Discuss, predict and estimate the variable by regression analysis with excel. (K2, K5, K6)			
7	Course Description	Enable students for using the computer program MS Excel, apply basic statistical techniques and methods for grouping, tabular and graphical display, analysis and interpretation of Statistical data.			
8	Outline syllabus				CO Mapping
	Unit 1	**Lab. Experiment 1:**			
		Exploring Data in Excel			CO1, CO2
	Unit 2	**Lab. Experiment 2:**			
		Create Charts			CO1, CO3
	Unit 3	**Lab. Experiment 3:**			
		Calculate Descriptive Statistics			CO1, CO4
	Unit 4	**Lab. Experiment 4:**			
		Calculate Correlation, Perform Regression			CO1,CO5
	Unit 5	**Lab. Experiment 5:**			
		Survey on gender ethics using statistical tools.			CO1, CO6
	Mode of examination	Practical			
	Weightage Distribution	CA	Viva	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book/s*				
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10

CO										
C152.1	3	3	2	2	2	3	2	2	1	1
C152.2	2	3	3	3	3	2	1	2	1	2
C152.3	2	3	2	2	3	2	3	2	2	3
C152.4	2	3	2	3	2	2	2	2	3	2
C152.5	3	3	2	3	2	2	2	2	2	3
C152.6	3	3	2	2	3	2	2	2	3	3

Mathematics Lab III MMT-153

School: SBSR		**Batch: 2021-23**
Program: M.Sc.		**Current Academic Year: 2021-22**
Branch: Mathematics		**Semester: II**
1	Course Code	MMT 153
2	Course Title	Mathematics Lab III
3	Credits	2
4	Contact Hours (L-T-P)	0-0-3
	Course Status	Compulsory
5	Course Objective	• To familiarize the student in introducing and exploring MATLAB software. • To enable the student on how to approach for solving problems using MATLAB tools. • To prepare the students to use MATLAB in their project works. • To provide a foundation in use of this software for real time applications.
6	Course Outcomes	CO1: Understand the procedures, algorithms, and concepts require to solve specific problems. (K2) CO2: Discuss and develop the algorithms to solve system of linear equations and measure the accuracy. (K2, K5, K6) CO3: Discuss and develop the algorithms to solve finite differences and interpolation and measure the accuracy. (K2, K5, K6) CO4: Discuss and develop the algorithms to solve system of transcendental equations and measure the accuracy. (K2, K5, K6) CO5: Discuss and develop the algorithms to solve divided differences and measure the accuracy. (K2, K5, K6) CO6: Discuss and develop the algorithms to solve numerical differentiation and integration and measure the accuracy. (K2, K5, K6)

7	Course Description	This course teaches computer programming to those with little to no previous experience. It uses the programming system and language called MATLAB to do so because it is easy to learn, versatile and very useful for engineers and other professionals. MATLAB is a special-purpose language that is an excellent choice for writing moderate-size programs that solve problems involving the manipulation of numbers.			
8	Outline syllabus				CO Mapping
	Unit 1	**Lab. Experiment 1:**			
		Solution of system of linear equations:			CO1, CO2
	Unit 2	**Lab. Experiment 2:**			
		System of Transcendental equations			CO1, CO3
	Unit 3	**Lab. Experiment 3:**			
		Finite differences and interpolation:			CO1, CO4
	Unit 4	**Lab. Experiment 4:**			
		Divided differences:			CO1,CO5
	Unit 5	**Lab. Experiment 5:**			
		Numerical differentiation and integration			CO1, CO6
	Mode of examination	Practical			
	Weightage Distribution	CA	Viva	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book/s*	Amos Gilot			
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C153.1	3	3	2	2	2	3	2	2	3
C153.2	2	3	3	2	3	2	3	3	2
C153.3	2	3	2	2	3	3	3	2	3
C153.4	2	3	2	3	2	2	2	2	2
C153.5	3	3	2	3	2	2	3	3	3

School: SBSR		**Batch: 2021-23**	
Program: M.Sc.		**Current Academic Year: 2021-22**	
Branch: Mathematics		**Semester: II**	
1	Course Code	MMT-154	
2	Course Title	Mathematics Lab IV	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-3	
	Course Status	Compulsory	
5	Course Objective	• To create understanding of the LaTeX and enable the students how to write resume, write question paper, write articles/ research papers.	
6	Course Outcomes	CO1: Understand the procedures installation of the software LaTeX. (K2) CO2: Discuss and explain Latex basic syntax and write equations, matrix, and tables. (K2, K4, K6) CO3: Explain and write page layout, equation references citation tables of contents list of figures etc. (K2, K4, K6) CO4: Describe how to write Geometry, Hyperref, amsmath, amssymb, algorithms in Latex. (K1, K2, K6) CO5: Discuss the classes and explain how to write article, book, report, beamer, slides. IEEtran. . (K2,K4, K6) CO6: Write resume, question paper, research paper, project in Latex . (K2, K5, K6)	
7	Course Description	This course teaches the LaTeXTo and describes how to write resume, write question paper, and write articles / research papers.	
8	Outline syllabus		CO Mapping
	Unit 1	**Lab. Experiment 1:**	
		Installation of the software LaTeX	CO1, CO2
		Understanding Latex compilation: Basic Syntex, Writing equations, Matrix, Tables	
	Unit 2	**Lab. Experiment 2:**	
		Page Layout – Titles, Abstract Chapters, Sections, References, Equation references, citation. List making environments Table of contents, Generating new commands, Figure handling numbering, List of figures, List of tables, Generating index.	CO3
	Unit 3	**Lab. Experiment 3:**	
		Packages: Geometry, Hyperref, amsmath, amssymb, algorithms, algorithmic graphic, color, tilez listing.	CO4

	Unit 4	**Lab. Experiment 4:**			
		Classes: article, book, report, beamer, slides. IEEtran.			CO5
	Unit 5	**Lab. Experiment 5:**			
		Applications to: Writing resume Writing question paper Writing articles/ research papers			CO6
	Mode of examination	Practical			
	Weightage Distribution	CA	Viva	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book/s*	LATEX for Beginners			
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C154.1	3	3	2	2	2	3	2	2	3
C154.2	2	3	3	2	3	2	3	2	2
C154.3	2	3	2	2	3	3	3	2	2
C154.4	2	3	2	2	2	2	2	2	2
C154.5	3	3	2	2	2	2	3	3	3

Mathematics Lab V (MMT 250)

School: SBSR		**Batch: 2021-23**
Program: M.Sc.		**Current Academic Year: 2022-23**
Branch: Mathematics		**Semester: III**
1	Course Code	MMT 250
2	Course Title	Mathematics Lab V
3	Credits	2
4	Contact Hours (L-T-P)	0-0-3
	Course Status	Compulsory
5	Course Objective	Introduce basic concepts of Scilab environment and provide students with a general understanding of Scilab workspace and working directory. Equip students with the skills to apply Scilab concepts and analytical tools to analyze and handle real-world issues.

6	Course Outcomes	CO1: Understand and discuss Scilab environment. (K2) CO2: Discuss and explain the importance of Scilab workspace and working directory. (K2, K5, K6) CO3: Discuss and Explain creating matrices and some simple matrix operations, Sub-matrices in Scilab. (K2, K5, K6) CO4: Discuss, calculate and understands the Statistics and polynomials in Scilab. (K2, K5, K6) CO5: Discuss, plot and interpret the graph in Scilab and explain Scilab programming language. (K2, K5, K6) CO6: Develop a deeper understanding of the write Scilab functions. (K2, K5, K6)			
7	Course Description	This course introduces the basic concepts of Scilab environment and provide students with a general understanding of Scilab workspace and working directory. Equip students with the skills to apply Scilab concepts and analytical tools to analyze and handle real-world issues.			
8	Outline syllabus				CO Mapping
	Unit 1				
		Scilab environment, Scilab as an interactive calculator			CO1, CO2
	Unit 2				
		Scilab workspace and working directory, Creating matrices and some simple matrix operations, Sub-matrices			CO1, CO3
	Unit 3				
		Statistics, Working with polynomials, Plotting graphs			CO1, CO4
	Unit 4				
		Scilab programming language, Script files and function files, Writing Scilab functions			CO1,CO5
	Unit 5				
		File operations, Reading Microsoft Excel files, Data Structures			CO1, CO6
	Mode of examination	Practical			
	Weightage Distribution	CA	Viva	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book/s*				
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4

C250.1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**3**
C250.2	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**2**
C250.3	**2**	**3**	**2**	**2**	**3**	**3**	**3**	**2**	**2**
C250.4	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
C250.5	**3**	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**3**

Project I

DISSERTATION-I (MMT 261)

School: SBSR		**Batch : 2021-23**	
Program: M.Sc.		**Current Academic Year: 2022-23**	
Branch: Mathematics		**Semester: III**	
1	Course Code	MMT 261	
2	Course Title	DISSERTATION-I	
3	Credits	4	
4	Contact Hours (L-T-P)	0-0-6	
	Course Status	Compulsory/Elective	
5	Course Objective	• Deep knowledge of a specific area of specialization. • Develop communication skills especially in project writing and oral presentation. Develop some time management skills.	
6	Course Outcomes	**CO1:** Explain the concept of research within the subject, as regards approaching a question, collecting and analysing background material and presenting research questions and conclusions. (K2, K4) **CO2:** Construct and develop a deeper interest in mathematics and taste for research. (K5, K6) **CO3:** Select and recommend the activities that support their professional goals. (K4, K6) **CO4:** Develop effective project organizational skills. (K5)	
7	Course Description	Maintain a core of mathematical and technical knowledge that is adaptable to changing technologies and provides a solid foundation for future learning.	
8	Outline syllabus		CO Achievement
	Unit 1	**Introduction**	**CO1**

	Unit 2	**Case study**			**CO1,CO2**
	Unit 3	**Conceptual**			**CO2,CO3**
	Unit 4	**Development**			**CO3**
	Unit 5	**Finalisation**			**CO3,CO4**
	Mode of examination	Jury/Practical/Viva			
	Weightage Distribution	CA	Viva	ETE	
		25 Marks	25 Marks	50 Marks	
	Text book/s*	-			
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C261.1	3	3	2	2	2	3	2	3	3
C261.2	2	3	3	2	3	2	3	3	2
C261.3	2	3	2	2	3	3	3	3	3
C261.4	2	3	2	2	2	3	2	3	2

Project II

DISSERTATION-2 (MMT 262)

School: SBSR		**Batch : 2021-23**	
Program: M.Sc.		**Current Academic Year: 2022-23**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	MMT 262	
2	Course Title	DISSERTATION-2	
3	Credits	6	
4	Contact Hours (L-T-P)	0-0-8	
	Course Status	Compulsory/Elective	
5	Course Objective	• Deep knowledge of a specific area of specialization. • Develop communication skills especially in project writing and oral presentation. Develop	

		some time management skills.	
6	Course Outcomes	**CO1:** Explain the concept of research within the subject, as regards approaching a question, collecting and analysing background material and presenting research questions and conclusions. (K2, K4) **CO2:** Construct and develop a deeper interest in mathematics and taste for research. (K5, K6) **CO3:** Select and recommend the activities that support their professional goals. (K4, K6) **CO4:** Develop effective project organizational skills. (K5)	
7	Course Description	Maintain a core of mathematical and technical knowledge that is adaptable to changing technologies and provides a solid foundation for future learning.	
8	Outline syllabus		CO Achievement
	Unit 1	**Introduction**	**CO1**
	Unit 2	**Case study**	**CO1,CO2**
	Unit 3	**Conceptual**	**CO2,CO3**
	Unit 4	**Development**	**CO3**
	Unit 5	**Finalisation**	**CO3,CO4**
	Mode of examination	Jury/Practical/Viva	
	Weightage Distribution	CA: 25 Marks; Viva: 25 Marks; ETE: 50 Marks	
	Text book/s*	-	
	Other References		

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C262.1	3	3	2	2	2	3	2	3	3
C262.2	2	3	3	2	3	2	3	3	2
C262.3	2	3	2	2	3	3	3	3	3
C262.4	2	3	2	2	2	3	2	3	2

Suggested Continuous Evaluation Methods: Max. Marks: 25		
S. N.	**Assessment Type**	**Max. Marks**
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation/** Research Orientation assignment	**5**
4	**Assignment (Indian Ancient Mathematics/ Statistics and Mathematicians/ Statisticians).**	**5**

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