SHARDA UNIVERSITY
Beyond Boundaries

Master of Science

Mathematics

AY: 2018- 19

Program and Course Structure

School of Basic Science and Research
Department of Mathematics

M. Sc. (Mathematics)

SBR0301

Batch 2018-20

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

M. Sc. (Mathematics)

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 Map 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-119	3	2	2	3	2	3	3	2	2
MMT-151	3	3	2	3	3	3	3	3	3
MMT-113	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
MMT-152	3	3	2	2	3	3	3	3	3
MMT-201	3	2	2	3	3	3	2	2	2

MMT-203	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-251	3	3	2	2	3	3	3	2	3
MMT-252	2	3	2	2	3	3	3	3	2
MMT-205	3	2	2	3	3	3	3	2	2
MMT-202	3	2	2	3	2	3	2	2	2
MMT-208	3	3	2	3	2	3	3	2	2
MMT-253	2	3	2	2	3	3	3	3	3

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

Department of Mathematics
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Batch: 2018-20

TERM: I

S. No.	SUBJECT CODE	Title of Paper	HOURS				CREDITS	PRE-REQUISITE/ CO-REQUISITE	Type of Course[1]: 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 119	INTRODUCTION to MATLAB AND ITS APPLICATIONS	3	-	-	3	2	CO-REQUISITE	AECC
	PRACTICALS								
6.	MMT 151	MATHEMATICS LAB- I	-	-	3	3	2	CO-REQUISITE	AECC
TOTAL			**19**	**-**	**3**	**22**			**20**

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

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Batch: 2018-2020
TERM: II

S. No.	SUBJECT CODE	Title of Paper	HOURS				CREDITS	PRE-REQUISITE/ CO-REQUISITE	Type of Course[2]: 5. CC 6. AECC 7. SEC DSE
	THEORY		**L**	**T**	**P**	**TOTAL**			
1.	MMT 113	NUMERICAL ANALYSIS WITH MATLAB	4	0	-	4	4	**CO-REQUISITE**	CC
2.	MMT 106	COMPLEX ANALYSIS	4	0	-	4	4	**CO-REQUISITE**	CC
3.	MMT 107	TOPOLOGY	4	0	-	4	4	**CO-REQUISITE**	CC
4.	MMT 108	DIFFERENTIAL GEOMETRY & TENSOR ANALYSIS	4	0	-	4	4	**CO-REQUISITE**	CC
5.	ENP 601	TECHNICAL PRESENTATION	-	0	4	2	2	**CO-REQUISITE**	SEC
	PRACTICALS								
6.	MMT 152	MATHEMATICS LAB- II	-	-	3	3	2	**CO-REQUISITE**	AECC
TOTAL			**16**	**-**	**7**	**21**	**20**		

[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	HOURS				CREDITS	PRE-REQUISITE/ CO-REQUISITE	Type of Course[3]: 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 203	LINEAR PROGRAMMING	4	-	-	4	4	CO-REQUISITE	CC
		SPECIALIZATION PAPERS (I & II)(OPT ANY TWO COURSES)							
3.	MMT 209 / MMT 204 / MMT-206	Graph Theory and its Applications / FLUID DYNAMICS / NUMBER THEORY WITH CRYPTOGRAPHY	4+ 4	-	-	8	8	CO-REQUISITE	AECC
	PRACTICALS								
4.	MMT 251	MATHEMATICS LAB- III	-	-	3	3	2	CO-REQUISITE	AECC
	DISSERTATION								
5.	MMT 252	**DISSERTATION-I** (A topic from specialization papers)	-	-		2	2	CO-REQUISITE	AECC
	TOTAL		**16**	**-**	**3**	**21**	**20**		

[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 Course[4]: 1. CC 2. AECC 3. SEC 4. DSE
	THEORY		**L**	**T**	**P**	**TOTAL**			
		SPECIALIZATION PAPERS (I & II)(OPT ANY TWO COURSES)							
1.	MST 205 / MMT202 / MMT 208	FUNCTIONAL ANALYSIS / Measure Theory/ DISCRETE MATHEMATICS	4+ 4	-	-	8	8	**CO-REQUISITE**	CC
	PRACTICALS	----	-	-	-	-----	-----	-----	----
	DISSERTATION								
2.	MMT 253	**DISSERTATION-2** (A topic from specialization papers)	-	-		8	8	**CO-REQUISITE**	AECC
TOTAL			**8**	**-**	**-**	**16**	**16**		

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

School: SBSR		**Batch : 2018-20**	
Program: M.Sc.		**Current Academic Year: 2018-19**	
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: 30%; MTE: 20%; ETE: 50%	
	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 (CO's) – PROGRAMME OUTCOMES (PO's) 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**

School: SBSR		**Batch : 2018-20**
Program: M.Sc.		**Current Academic Year: 2018-19**
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	
		30%	20%	50%	
	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**

School: SBSR		**Batch : 2018-20**
Program: M. Sc.		**Current Academic Year: 2018 - 19**
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	
		30%	20%	50%	
	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**

School: SBSR		**Batch : 2018-20**
Program: M. Sc.		**Current Academic Year: 2018 - 19**
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 Outcomes	CO1: Describe the overall process and particular steps in designing studies, 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, liminf 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
		30%	20%	50%
	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 : 2018-20**	
Program: M.Sc.		**Current Academic Year: 2018-19**	
Branch: Mathematics		**Semester: I**	
1	Course Code	MMT-119	
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 If-End statement, If-Else –End statement	CO1, CO3
	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	
		30%	20%	50%	
	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
C119.1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**
C119.2	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**1**	**2**
C119.3	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**1**
C119.4	**2**	**2**	**1**	**2**	**2**	**2**	**3**	**1**	**1**
C119.5	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**
C119.6	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**1**	**2**

School: SBSR		**Batch : 2018-20**
Program: M.Sc.		**Current Academic Year: 2018-19**
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	
		30%	20%	50%	
	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**

School: SBSR		**Batch : 2018-20**
Program: M.Sc.		**Current Academic Year: 2018-2019**
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	
		30%	20%	50%	
	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**

School: SBSR		**Batch : 2018-20**
Program: M.Sc.		**Current Academic Year: 2018-2019**
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: 30%; MTE: 20%; ETE: 50%	
	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.	

SHARDA UNIVERSITY
Beyond Boundaries

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

School: SBSR		**Batch : 2018-20**
Program: M. Sc.		**Current Academic Year: 2018 - 19**
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	CO1: Describe the concept of local theory of curves: space curves, Osculating plane,

	Outcomes	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	
		30%	20%	50%	
	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**

School: SBSR		**Batch : 2018-20**
Program: M. Sc.		**Current Academic Year: 2019-20**
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 normal subgroup, sylow groups and evaluate internal and external direct product. (K1,K2,K5) CO3: Explain the concepts of homomorphism, isomorphism and analysis automorphism and inner- automorphism. (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	Subgroups, quotient groups,	CO1
	B	Permutation group,	CO1
	C	Lagrange's theorem and the result about its converse.	CO1
	Unit 2	**Normal Subgroups and Sylow theorem**	
	A	Normal subgroups and factor groups and applications.	CO2
	B	Cauchy's and Sylow's theorems and applications,	CO2
	C	Finitely generated Abelian groups, internal and external direct products. Examples.	CO2

	Unit 3	**Homomorphism and Isomorphism**			
	A	Homomorphism of groups, kernel of a homomorphism,			CO3
	B	Definition of isomorphism, Automorphism,			CO3
	C	Inner automorphisms.			CO3
	Unit 4	**Ring Theory**			
	A	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	**Extension of fields**			
	A	Algebraic extensions			CO6
	B	Roots of polynomials			CO6
	C	Splitting fields			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	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, 3^{rd}.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**

School: SBSR		**Batch : 2018-20**
Program: M.Sc.		**Current Academic Year: 2019-2020**
Branch: Mathematics		**Semester: III**
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	
		30%	20%	50%	
	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

School: SBSR		**Batch : 2018-20**
Program: M.Sc.		**Current Academic Year: 2019-20**
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	CO5

		elimination ordering),	
	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, Chvatal's theorem and toughness of a graph.	CO6
	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: 30% / MTE: 20% / ETE: 50%	
	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**

School: SBSR		**Batch : 2018-20**
Program: M.Sc.		**Current Academic Year: 2019-20**
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; Velocity and acceleration in an Eulerian flow field;	CO2
	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: 30% · MTE: 20% · ETE: 50%	
	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**

School: SBSR		**Batch : 2018-20**
Program: M.Sc.		**Current Academic Year: 2019-20**
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	
		30%	20%	50%	
	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. • G. H. Hardy & E. M. Wright : An Introduction to the theory of Numbers.			
	Other References				

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

School: SBSR		**Batch : 2018-20**
Program: M.Sc.		**Current Academic Year: 2019-20**
Branch: Mathematics		**Semester: IV**
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	Foundation course in Mathematics			CO Mapping
	Unit 1	**Normed linear spaces**			
	A	Normed linear spaces, Holder's inequality, Minkowski's inequality			CO1
	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	
		30%	20%	50%	
	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**

School: SBSR		**Batch : 2018-20**
Program: B.SC		**Current Academic Year: 2019-2020**
Branch: Mathematics		**Semester: IV**
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 measurable functions, Fatou's lemma.	CO2
	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: 30%	MTE: 20%	ETE: 50%	
	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**

School: SBSR		**Batch : 2018-20**
Program: M.Sc.		**Current Academic Year: 2019-2020**
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	CO5

		their subgraphs, Walks, Path and circuits, Connected graphs, Disconnected graphs and componant	
	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: 30%; MTE: 20%; ETE: 50%	
	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**

Syllabus of MMT-151 (Practical)

School: SBSR		**Batch : 2018-20**
Program: M.Sc.		**Current Academic Year: 2018-19**
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 Solving a system of linear equations, curve fitting with polynomials using inbuilt functions such as polyfit.			**CO2,CO5**
	Mode of examination	Practical &Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	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**

Syllabus of MMT-152 (Practical)

School: SBSR		**Batch : 2018-20**	
Program: M.Sc.		**Current Academic Year: 2018-19**	
Branch: Mathematics		**Semester: II**	
1	Course Code	MSM 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 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	MTE	ETE	
		60%	0%	40%	
	Text book/s*	Amos Gilot			
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C152.1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**3**
C152.2	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**2**
C152.3	**2**	**3**	**2**	**2**	**3**	**3**	**3**	**2**	**3**
C152.4	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**2**
C152.5	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**3**

Syllabus of MMT-251 (Practical)

School: SBSR		**Batch : 2018-20**	
Program: M.Sc.		**Current Academic Year: 2019-20**	
Branch: Mathematics		**Semester: III**	
1	Course Code	MMT-251	
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 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,	CO4

		algorithms, algorithmic graphic, color, tilez listing.			
	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	MTE	ETE	
		60%	0%	40%	
	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
C251.1	3	3	2	2	2	3	2	2	3
C251.2	2	3	3	2	3	2	3	2	2
C251.3	2	3	2	2	3	3	3	2	2
C251.4	2	3	2	2	2	2	2	2	2
C251.5	3	3	2	2	2	2	3	3	3

Syllabus of Project I

School: SBSR		**Batch : 2018-20**		
Program: M.Sc.		**Current Academic Year: 2019-20**		
Branch: Mathematics		**Semester: III**		
1	Course Code	MMT 252		
2	Course Title	DISSERTATION-I		
3	Credits	2		
4	Contact Hours (L-T-P)	0-0-3		
	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	MTE	ETE
		60%	0%	40%
	Text book/s*	-		
	Other References			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C252.1	3	3	2	2	2	3	2	3	3
C252.2	2	3	3	2	3	2	3	3	2
C252.3	2	3	2	2	3	3	3	3	3
C252.4	2	3	2	2	2	3	2	3	2

Syllabus of Project II

School: SBSR		**Batch : 2018-20**	
Program: B.Sc.		**Current Academic Year: 2019-20**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	MMT 253	
2	Course Title	DISSERTATION-2	
3	Credits	8	
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	MTE	ETE	
		60%	0%	40%	
	Text book/s*	-			
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
C253.1	3	3	2	2	2	3	2	3	3
C253.2	2	3	3	2	3	2	3	3	2
C253.3	2	3	2	2	3	3	3	3	3
C253.4	2	3	2	2	2	3	2	3	2

---- THE END -----