



MAHARAJA RANJIT SINGH PUNJAB TECHNICAL UNIVERSITY BATHINDA-151001 (PUNJAB), INDIA

(A State University Estb. by Govt. of Punjab vide Punjab Act No. 5 of 2015 and Approved u/s 2(f) & 12 (B) of UGC; Member AIU)

Department: **MATHEMATICS**
MRSPTU main campus ,Bathinda

Program: **M.Sc.**

COURSE ARTICULATION MATRIX (STUDY SCHEME: 2016)

Subject	S Code	Semester	Credit	Duration (Hrs)	L T P	Cos	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
Abstract Algebra	MMAT1-101	1	4	4 5	4 0 0	CO1	Analyze & demonstrate different types of algebraic structures such as subgroups Normal subgroups, Quotient groups and Sylow theorems to solve different types of problems.	3	1			1	1			1					2	1	

						CO2	Understand proofs of some results such as Fundamental theorem of arithmetic, Solvable groups to understand and use the fundamental results in Algebra. and Jordan -holder theorem.	1	2			2	1			2		2	1				
						CO3	Understand the concept of Ring and subring, various type of ideals	2	2			2	2			2		2	1	1			
						CO4	Apply various concepts of factorization domains in real life problems	1	1			1	1			2		2	1				
Real Analysis	MMAT1-102	1	4	4	5	400	CO1	Describe fundamental properties of the real numbers that lead to the formal development of real analysis.		2		3	1					2	1	2			
							CO2	Demonstrate an understanding of limits and how they are used in sequences, series, Construct rigorous mathematical proofs of basic results in real analysis.								2	2			2	2	1	2
							CO3	Understand Integrability and theorems on integrability. Recognize the difference between point wise and uniform convergence of a sequence of functions.				2	2						3	2	1	2	
							CO4	Illustrate the effect of uniform convergence on the limit function with respect to continuity, differentiability, and integrability.	1			1							2	2	1	3	

Mechanics	MMAT1-I03	1	400	CO1	Use of the Lagrange's equation for deriving equation of motions		2			2	1	2		2			2	3	1		
		4		CO2	Understand necessary conditions for the equilibrium of particles acted upon by various forces and learn the principle of virtual work for a system of coplanar forces acting on a rigid body.		1		3				1	1				2	1	1	
		4		CO3	Deal with the kinematics and kinetics of the rectilinear and planar motions of a particle including the constrained oscillatory motions of particles.		1			2	3								2	3	2
		5		CO4	Learn that a particle moving under a central force describes a plane curve and know the Kepler's laws of the planetary motions, which were deduced by him long before the mathematical theory given by Newton.		2		2	2				2					1	2	2
		400		CO1	Understand the concept of existence and uniqueness of solutions and also emphasizes the justification of methods for approximating solutions in pure and applied mathematics	2	3			2	1			1		1			1	1	
Differential equations	MMAT1-I04	1	4	4	5	400	CO1	Understand the concept of existence and uniqueness of solutions and also emphasizes the justification of methods for approximating solutions in pure and applied mathematics	2	3			2	1			1		1	1	

						CO2	Understand partial differential equations of various type, their classification and solution	2	2	1	2					2			2	1				
						CO3	Determine integral surfaces passing through a curve, characteristic curves of second order PDE and compatible systems	2	1		1								2	1	1			
						CO4	Discuss about autonomous system , Phase plane and critical points etc. continuity,	1	2				1	3					1		1			
Fundamentals of Computer and C Programming	MCAPO-193	1	4	4	5	400	CO1	Implement programs using C.	1	1	1	1	1	1	2	2	3	3	3	2	1	1	2	
							CO2	Implement fundamental data structures in C.	1	1	1	1	2	2	2	2	3	3	3	3	2	1	2	2
							CO3	Understand the fundamentals of hardware, software, and programming.	1	1	1	2	2	2	2	2	3	3	3	3	2	1	2	2
							CO4	Understand the logic building used in Programming	1	1	1	2	2	2	2	2	3	3	3	3	2	1	2	2
Fundamentals of Computer and C Programming Lab	MCAPO-194	1	1	6	0	002	CO1	Implement programs using C.	1	1	1	1	1	1	2	2	3	3	3	2	1	1	2	
							CO2	Implement fundamental data structures in C.	1	1	1	1	2	2	2	2	3	3	3	3	2	1	2	2
							CO3	Write the programming solutions for solving various real-life problems	1	1	1	2	2	2	2	2	3	3	3	3	2	1	2	2
							CO4	Implement Programs with pointers and arrays, perform pointer arithmetic, and use the pre-processor.	1	1	1	2	2	2	2	2	3	3	3	3	2	1	2	2

Advanced Algebra	MMATI-205	2	4	4 5	400	CO1	Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.	3	1			1	1			1			2	1	
						CO2	Prove the basic results of inner product space, field extensions, Finite fields and Galois Theory.	1	2			2	1			2			2	1	1
						CO3	Apply the concepts of Gauss Lemma, Einstein's irreducibility criterion, separable extensions etc.	2	2			2	2			2			2	1	1
						CO4	Understand the logic building used in Programming	1	1			1	1			2				1	2
Measure Theory and Integration	MMATI-206	2	4	4 5	400	CO1	Understand and implement the idea of Lebesgue Measure of Sets and Functions.		3			2	1						3		2
						CO2	Document insight in modern theory of integration as a tool in advanced analysis and in statistics		2		2	1							3	1	1
						CO3	Analyse the comparison of Riemann and Lebesgue integral		1	2					2	2			2		1
						CO4	Implement Lebesgue Integration and Lebesgue Differentiation, Fatou's Lemma & Theory on LP-Space		2			3		1					2		1

Complex Analysis	MMAT1-207	2	4	4 5	4 00	CO1	Understand the concept and consequences of analyticity and Cauchy-Riemann equations and knowing basic difference between real & complex calculus and conformal mappings.		3		2			3	3		1			3	1		
						CO2	Understanding Geometrical interpretation of Complex functions.	1	2	2	2	3		2							3	2	1
						CO3	Evaluation of contour integrals directly by the use of Cauchy's theorem and Cauchy's integral formula.			2	1	3		2		3					3	1	1
						CO4	Represent functions as Taylor, power and Laurent series, classify singularities and poles, find residue and complex integrals using residue theorem.		2			1				2						3	2
Tensor and Differential Geometry	MMAT1-208	2	4	4 5	4 00	CO1	Explain the basic concepts of tensors, Understand role of tensors in differential geometry.		1			2					1			1	2		
						CO2	Learn various properties of curves including Frenet-Serret formulae and their applications		2	3			2	1	1						2	1	
						CO3	Know the Interpretation of the curvature tensor, Geodesic curvature, Gauss and Weingarten formulae		3				2	1							1	2	1
						CO4	Explain the concepts of differential geometry and its role in modern Mathematics		3	2			2	2				1			2	1	1

Numerical Analysis	MMATI-209	2	4	4 5	400	CO1	To analyze different types of errors incumbent in any such numerical approximation.	1	1			1	1			1			1	2		
						CO2	Introduce the basic concepts of Numerical Mathematics to solve the problems arising in science and engineering etc.	1	2			2	1			2			1	3	1	
						CO3	Compare the viability of different approaches to the numerical solution of problems arising in roots of solution of nonlinear equations, interpolation, numerical differentiation and integration	2	2		2	2	2			2			2	1	1	
						CO4	Apply numerical methods for solving different types of problems related to initial and boundary value problems of ordinary differential equations etc.	1	1		1	1	1			3			2	1	2	
Numerical Analysis lab	MMATI-210	2	1	3 0	002	CO1	Apply computer programming to solve algebraic equations, linear systems of equations, ordinary differential equation, eigenvalue problems & Carry out numerical differentiation, integration and interpolation.		1			1	1	1		1	2			2	1	2
						CO2	Utilize the symbolic tools of C++ language for solving given problem.		2			2	1	2		2	3			1	2	3
						CO3	Understand different modes of a numerical method in order to solve a given		2	2		2	2	3		2	1			1	2	2

							problem efficiently.															
							Develop understanding of numerical error and applicability of a particular method	1	2	1	1	3	3	2			2		2			
Topology	MMAT1-311	3	4	4	400	CO1	Illustrate the concept of topological spaces and continuous functions, product topology and quotient topology.	1		2				2			1	1	3			
				5		CO2	Distinguish different examples of general, geometric and algebraic topology.			1	2	3	2		2			1	2	3		
						CO3	Understand several standard concepts of metric spaces and their properties like openness, closeness, completeness, compactness, and connectedness.			1	2	3						2	2	3		
						CO4	Identify the continuity of a function defined on metric spaces and homeomorphisms.	1			2	2			2	2			2	2	3	
Operations research	MMAT1-312	3	4	4	400	CO1	Construct an optimization problem from its physical interpretation to get its solution by using a suitable optimization technique.	1	3		2						2	1	1			
				5		CO2	Implement an appropriate optimization technique to solve a particular optimization problem.	1	1		2	2		1			1	2	1			
						CO3	Apply the knowledge of basic optimization techniques to get the best possible results from a set of several possible solutions of transportation					1	2		2			1	1	1		

							and assignment problems.															
						CO4	Use the ideas of basic optimization techniques to do interesting research work on such types of optimization techniques.				1	2		1				1	1	3		
Mathematical Statistics	MMAT1-313	3	4	4	400	CO1	To understand the concept of probability theory and statistics to solve industrial problems and Demonstrate of application of all Distributions in various domain		1	1	2	1	1			1	1	1		1		
				5		CO2	Study the various discrete and continuous distributions	2	2	1	2			1	2	1			1		1	
						CO3	Understand the concept and derivation of Chi square ,t and z distributions with its standard errors , mean and variance with their random sampling from normal distributions.	1	2		1			1	1	2			1	1		1
						CO4	Testing of hypothesis and its significance based on different distributions , transformation of correlation , regression and analysis of variance.	2	1		2	1	1		1	1				2		2
Mathematical Methods	MMAT1-314	3	4	4	400	CO1	Understand the concept of functional and importance of their applications.		3		1	2			2			3		1		

						CO2	Find stationary values or paths and use of Euler-Lagrange equations.		3			2				1			2	1	1		
						CO3	Understand the concept of integral equations and its types along with solutions by various methods.		2				1			3				2		2	
						CO4	Convert Differential equations into integral equations and vice versa.		2					2		2				2		2	
Seminar-I	MMAT1-315	3	1	3	002	CO1	Inculcate confidence to communicate effectively through soft skills and presentations.			1						3		1	2			1	
						CO2	Enhance the subject enrichment through the detail study of the topic to be presented		2	1									1		2	1	1
						CO3	Development of innovation and creativity through the selection and preparation of topic to be presented.		2	1							2			2			2
						CO4	Develop the ethical skills and team work responsibilities through the discussion of preparation of the presentations.					1					3		3	2		2	
Fourier Analysis and Applications	MMAT1-356	3	4	4	5	400	CO1	Concept of Fourier series and its importance in various fields		3			2	1	2						3	1	1

						CO2	Understand the basic concepts of Fourier analysis.		2		3							3	2	1		
						CO3	Understand the use of Fourier transforms and its applications to Boundary Value problems	2			3	2						3	2			
						CO4	Able to have knowledge about Discrete Fourier transforms Fast Fourier transforms and their use in technology		2		2	2						2	2			
Advanced Numerical Analysis	MMATI-357	3	4	4	5	400	CO1	Find numerical solutions of system of linear equations and check the accuracy of the solutions.		2			3	1	1		2			2	2	3
							CO2	Compare the viability of different approaches to the numerical solution of problems arising in roots of solution of nonlinear equations, Finite difference methods		2			3				1	1		2	1	3
							CO3	Solve initial and boundary value problems in differential equations using numerical methods.						1	3					2	1	2
							CO4	Apply various numerical methods in real life problems like finite element method.		2			2	1			2			2	2	2
Number Theory	MMATI-416	4	4	4	5	400	CO1	Define divisibility, greatest common divisor, Prime numbers, congruence,					1	2						2		
							CO2	Understand the concept of Mobius function $\mu(n)$, The Euler totient function $\phi(n)$,		2	1			2	1							

Partial Differential Equations	MMATI-418	4	4	4	400	CO1	Apply a range of techniques to solve first & second order partial differential equations.			1	2	3						2	2	2		
				5		CO2	Model physical phenomena using partial differential equations such as the heat and wave equations.			1	2	2	3	2					2	2	3	
						CO3	Recognize the major classification of PDEs and the qualitative differences between the classes of equations.			1		2	3							2	1	2
						CO4	Formulate mathematical models in the form of ordinary and partial differential equations to problems arising in physical, chemical and biological disciplines.	1			2		2	3						2	2	2
Seminar-II	MMATI-419	4	1	3	002	CO1	Inculcate confidence to communicate effectively through soft skills and presentations.			1						3		1	2		1	
				0		CO2	Enhance the subject enrichment through the detail study of the topic to be presented.		2	1									1		2	1

						CO3	Development of innovation and creativity through the selection and preparation of topic to be presented.		2	1						2		2		2				
						CO4	Develop the ethical skills and team work responsibilities through the discussion of preparation of the presentations.					1			3		3	2		2	2			
Advanced Operations Research	MMAT1-458	4	4	4	400	CO1	Formulate mathematical models involving Queuing theory and inventory problems from its physical considerations.		1	3						1				1	1	1		
				5		CO2	Apply the knowledge of mathematical techniques in order to get the solution of Queuing and inventory models.		2				2	1	2						1	2	2	
						CO3	Continue to acquire the knowledge and skills of mathematical modelling involving the problems of replacement and maintenance of equipment.									2		2				1	2	2
						CO4	Understand the formulation and use of networks for the solution of the maximal flow problem, the shortest-path problem and the minimal spanning tree problem.							2		2		1				1	2	1
Advanced Complex Analysis	MMAT1-459	4	4	4	400	CO1	Manipulate complex numbers in various representations.	2	3			1		2						3	2			
				5		CO2	Define and calculate limits and derivatives of functions of a complex variable. State and prove fundamental		3		2			2	2		2				2	1		

							results, including: Cauchy's Theorem and Cauchy's Integral Formula																		
							CO3 Understanding Geometrical interpretation of Complex functions		2			3	1	2					2	1					
							CO4 Understand Fundamental Theorem of Algebra, Morera's Theorem and Liouville's Theorem and use them to prove related results.		2			3	1	2					2	2					
Fractional Calculus	MMAT1-460	4	4	4	400	5	CO1 Apply the knowledge to evaluate fractional integrals of some common functions by understanding the Riemann-Liouville fractional integral	2	2					2				1			1	1	1		
						CO2 Define the Leibniz's formula of fractional derivatives and find the fractional derivatives of some common functions	2	2														1		1	
						CO3 Develop the skills to solve the linear fractional differential equations using the Laplace transform.	2	1							2	2	1		2				1		1
						CO4 Introduce the Leibniz formula for Weyl fractional integral and investigate some applications of the fractional calculus to the real world.		2						1	2	2		2					1	1	1
Graph Theory	MMAT1-461	4	4	4	400	5	CO1 Define the basic concept of graphs, its types and properties		2	3						2					3				
						CO2 Define the properties of trees, and to understand the concept of colouring and theory	3	1									2					2	2	1	

						CO3	Understand Eulerian and Hamiltonian graphs with results.		2	3		2						1		2			
						CO4	Understand the connectivity and paths, edges and cycles.		2	3			3					1		2	2		
Sampling Distribution and Estimation Theory	MMATI-462	4	4	4	400	CO1	Understand the idea of Sampling and its types, to know the concept of Estimation Theory, Distributions and Sampling Tests- F- Test, Chi square test.					2	1	2		1				1			
				5		CO2	Understand problem of statistical inference, problem of point estimation , Properties of point estimator such Consistency, Unbiasedness, Sufficiency		2	1	1			2									
						CO3	Obtain minimum variance unbiased estimator.		2	1	1			2									2
						CO4	Obtain estimators using estimation methods such as Maximum likelihood& its properties, Minimum chi square, method of moments, method of scoring.					2	1		1	1	3					2	2
Fuzzy Set Theory and Applications	MMATI-463	4	4	4	400	CO1	Identify fuzzy sets and perform set operations.		2		2	2				1	1			3	1		
				5		CO2	Classify the various operations on fuzzy sets	1	3			2				1	1			2	1		
						CO3	Apply fuzzy logic in various real life situations.		2			3					1			1	2		

						CO4	Decide the difference between crisps and fuzzy set theory.		2			1	1					2		2				
Computer Application in Business	MCAPO-F91	4	3	4	300	CO1	Describe the fundamentals of Information Technology (IT) infrastructure components: hardware, software, and data communications systems.	1	1	2	1	1	1	2	2	3	3	3	2	1	2	2		
						CO2	Identify emerging technologies for use in business applications.	1	1	2	1	2	1	2	3	3	3	3	2	1	2	2		
						CO3	Demonstrate basic skills involving spreadsheet functions; create formulas, charts, and graphs; manipulate data; and generate reports	1	1	2	2	2	2	2	2	3	3	3	3	2	1	2	2	
						CO4	Gain an education for office careers by focusing on developing communication skills as well as skills in office technology systems.	1	1	2	2	2	2	2	2	3	3	3	3	2	1	2	2	
Business Ethics	MBAD0-F97	4	3	4	300	CO1	Understand role the ethics and values in Business.								3				1		1			
						CO2	Understand role the ethics in functioning of various departments of organization like Marketing, Finance & HR.									1				2	1			
						CO3	Analyze the ethics in society and Business.					1	1	1	2									
						CO4	Implement Individual & Group policies and laws of ethics.									2			1	2				



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Subject	S Code	Semester	Credit	Duration (Hrs)	LTP	Cos	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Abstract Algebra	MMAT1-101	1	4	60	400	CO1	Analyze & demonstrate different types of algebraic structures such as subgroups Normal subgroups, Quotient groups and Sylow theorems to solve different types of problems.	3	1			1	1			1				2	1	
						CO2	Understand proofs of some results such as Fundamental theorem of arithmetic, Solvable groups to understand and use the fundamental results in Algebra. and Jordan -holder theorem.	1	2			2	1			2						

						CO3	Understand the concept of Ring and subring, various type of ideals	2	2			2	2			2			2	1	1		
						CO4	Apply various concepts of factorization domains in real life problems	1	1			1	1			2			2	1			
Real Analysis	MMAT1-102	1	4	6	0	400	CO1	Describe fundamental properties of the real numbers that lead to the formal development of real analysis.		2		3		1					2	1	2		
							CO2	Demonstrate an understanding of limits and how they are used in sequences, series, Construct rigorous mathematical proofs of basic results in real analysis.				2	2				2			2	1	2	
							CO3	Understand Integrability and theorems on integrability. Recognize the difference between point wise and uniform convergence of a sequence of functions.				2		2				3			2	1	2
							CO4	Illustrate the effect of uniform convergence on the limit function with respect to continuity, differentiability, and integrability.	1			1						2			2	1	3

Mechanics	MMAT1-I03	1	4	6	400	CO1	Use of the Lagrange's equation for deriving equation of motions		2			2	1	2				2	3	1				
				0			CO2	Understand necessary conditions for the equilibrium of particles acted upon by various forces and learn the principle of virtual work for a system of coplanar forces acting on a rigid body.		1		3				1	1			2	1	1		
							CO3	Deal with the kinematics and kinetics of the rectilinear and planar motions of a particle including the constrained oscillatory motions of particles.		1			2	3							2	3	2	
							CO4	Learn that a particle moving under a central force describes a plane curve and know the Kepler's laws of the planetary motions, which were deduced by him long before the mathematical theory given by Newton.		2		2	2				2					1	2	2
Differential equations	MMAT1-I04	1	4	6	400	CO1	Understand the concept of existence and uniqueness of solutions and also emphasizes the justification of methods for approximating solutions in pure and applied mathematics	2	3			2	1				1		1					

						CO2	Understand partial differential equations of various type, their classification and solution	2	2	1	2					2			2	1				
						CO3	Determine integral surfaces passing through a curve, characteristic curves of second order PDE and compatible systems	2	1		1								2	1	1			
						CO4	Discuss about autonomous system , Phase plane and critical points etc. continuity,	1	2				1	3					1		1			
Fundamentals of Computer and C Programming	MCAPO-193	1	4	6	0	400	CO1	Implement programs using C.	1	1	1	1	1	1	2	2	3	3	3	2	1	1	2	
							CO2	Implement fundamental data structures in C.	1	1	1	1	2	2	2	2	3	3	3	3	2	1	2	2
							CO3	Understand the fundamentals of hardware, software, and programming.	1	1	1	2	2	2	2	2	3	3	3	3	2	1	2	2
							CO4	Understand the logic building used in Programming	1	1	1	2	2	2	2	2	3	3	3	3	2	1	2	2
Fundamentals of Computer and C Programming Lab	MCAPO-194	1	1	3	0	002	CO1	Implement programs using C.	1	1	1	1	1	1	2	2	3	3	3	2	1	1	2	
							CO2	Implement fundamental data structures in C.	1	1	1	1	2	2	2	2	3	3	3	3	2	1	2	2
							CO3	Write the programming solutions for solving various real-life problems	1	1	1	2	2	2	2	2	3	3	3	3	2	1	2	2
							CO4	Implement Programs with pointers and arrays, perform pointer arithmetic, and use the pre-processor.	1	1	1	2	2	2	2	2	3	3	3	3	2	1	2	2

Advanced Algebra	MMATI-205	2	4	60	400	CO1	Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.	3	1			1	1			1			2	1				
						CO2	Prove the basic results of inner product space, field extensions, Finite fields and Galois Theory.	1	2			2	1			2				2	1	1		
						CO3	Apply the concepts of Gauss Lemma, Einstein's irreducibility criterion, separable extensions etc.	2	2			2	2			2					2	1	1	
						CO4	Understand the logic building used in Programming	1	1			1	1			2						1	2	
Measure Theory and Integration	MMATI-206	2	4	60	400	CO1	Understand and implement the idea of Lebesgue Measure of Sets and Functions.		3				2	1						3		2		
						CO2	Document insight in modern theory of integration as a tool in advanced analysis and in statistics		2		2	1									3	1	1	
						CO3	Analyse the comparison of Riemann and Lebesgue integral		1	2						2	2					2		1
						CO4	Implement Lebesgue Integration and Lebesgue Differentiation, Fatou's Lemma & Theory on LP-Space		2			3		1								2		1

Complex Analysis	MMAT1-207	2	4	60	400	CO1	Understand the concept and consequences of analyticity and Cauchy-Riemann equations and knowing basic difference between real & complex calculus and conformal mappings.		3		2			3	3		1			3	1		
						CO2	Understanding Geometrical interpretation of Complex functions.	1	2	2	2	3		2							3	2	1
						CO3	Evaluation of contour integrals directly by the use of Cauchy's theorem and Cauchy's integral formula.			2	1	3		2		3					3	1	1
						CO4	Represent functions as Taylor, power and Laurent series, classify singularities and poles, find residue and complex integrals using residue theorem.		2			1				2					3	2	
Tensor and Differential Geometry	MMAT1-208	2	4	60	400	CO1	Explain the basic concepts of tensors, Understand role of tensors in differential geometry.		1			2					1			1	2		
						CO2	Learn various properties of curves including Frenet-Serret formulae and their applications		2	3			2	1	1						2	1	
						CO3	Know the Interpretation of the curvature tensor, Geodesic curvature, Gauss and Weingarten formulae		3				2	1							1	2	1
						CO4	Explain the concepts of differential geometry and its role in modern Mathematics		3	2			2	2				1			2	1	1

Numerical Analysis	MMATI-209	2	4	6 0	400	CO1	To analyze different types of errors incumbent in any such numerical approximation.	1	1			1	1			1			1	2		
						CO2	Introduce the basic concepts of Numerical Mathematics to solve the problems arising in science and engineering etc.	1	2			2	1			2			1	3	1	
						CO3	Compare the viability of different approaches to the numerical solution of problems arising in roots of solution of nonlinear equations, interpolation, numerical differentiation and integration	2	2		2	2	2			2			2	1	1	
						CO4	Apply numerical methods for solving different types of problems related to initial and boundary value problems of ordinary differential equations etc.	1	1		1	1	1			3			2	1	2	
Numerical Analysis lab	MMATI-210	2	1	3 0	002	CO1	Apply computer programming to solve algebraic equations, linear systems of equations, ordinary differential equation, eigenvalue problems & Carry out numerical differentiation, integration and interpolation.		1			1	1	1		1	2			2	1	2
						CO2	Utilize the symbolic tools of C++ language for solving given problem.		2			2	1	2		2	3			1	2	3
						CO3	Understand different modes of a numerical method in order to solve a given		2	2		2	2	3		2	1			1	2	2

							problem efficiently.															
							Develop understanding of numerical error and applicability of a particular method	1	2	1	1	3	3	2			2			2		
Topology	MMAT1-311	3	4	6	400	CO1	Illustrate the concept of topological spaces and continuous functions, product topology and quotient topology.	1			2					2			1	1	3	
						CO2	Distinguish different examples of general, geometric and algebraic topology.			1	2		3	2			2			1	2	3
						CO3	Understand several standard concepts of metric spaces and their properties like openness, closeness, completeness, compactness, and connectedness.			1		2	3							2	2	3
						CO4	Identify the continuity of a function defined on metric spaces and homeomorphisms.	1			2		2				2	2			2	2
Operations research	MMAT1-312	3	4	6	400	CO1	Construct an optimization problem from its physical interpretation to get its solution by using a suitable optimization technique.		1	3			2						2	1	1	
						CO2	Implement an appropriate optimization technique to solve a particular optimization problem.		1	1			2		2		1			1	2	1
						CO3	Apply the knowledge of basic optimization techniques to get the best possible results from a set of several possible solutions of transportation							1		2		2			1	1

							and assignment problems.															
						CO4	Use the ideas of basic optimization techniques to do interesting research work on such types of optimization techniques.				1	2		1				1	1	3		
Mathematical Statistics	MMAT1-313	3	4	60	400	CO1	To understand the concept of probability theory and statistics to solve industrial problems and Demonstrate of application of all Distributions in various domain		1	1	2	1	1			1	1	1		1		
						CO2	Study the various discrete and continuous distributions	2	2	1	2			1	2	1			1		1	
						CO3	Understand the concept and derivation of Chi square ,t and z distributions with its standard errors , mean and variance with their random sampling from normal distributions.	1	2		1			1	1	2			1	1		1
						CO4	Testing of hypothesis and its significance based on different distributions , transformation of correlation , regression and analysis of variance.	2	1		2	1	1		1	1				2		2
Mathematical Methods	MMAT1-314	3	4	60	400	CO1	Understand the concept of functional and importance of their applications.		3		1	2			2			3		1		

						CO2	Find stationary values or paths and use of Euler-Lagrange equations.		3			2				1			2	1	1		
						CO3	Understand the concept of integral equations and its types along with solutions by various methods.		2				1			3			2		2		
						CO4	Convert Differential equations into integral equations and vice versa.		2					2		2			2		2		
Seminar-I	MMATI -315	3	1	3	0	CO1	Inculcate confidence to communicate effectively through soft skills and presentations.			1						3		1	2			1	
						CO2	Enhance the subject enrichment through the detail study of the topic to be presented		2	1								1		2	1	1	
						CO3	Development of innovation and creativity through the selection and preparation of topic to be presented.		2	1						2		2		2		2	
						CO4	Develop the ethical skills and team work responsibilities through the discussion of preparation of the presentations.					1				3		3	2	2		2	
Fourier Analysis and Applications	MMATI -356	3	4	6	0	CO1	Concept of Fourier series and its importance in various fields		3			2	1	2		2				3	1	1	
						CO2	Understand the basic concepts of Fourier analysis.		2		3					1	1				3	2	1
						CO3	Understand the use of Fourier transforms and its applications to Boundary Value problems	2				3	2								3	2	

						CO4	Familiar with elementary theorems on Distribution of prime numbers, Dirichlet character.			1		1	2	2					2		2
Functional Analysis	MMATI-417	4	4	6	400	CO1	Analyze the basic idea of finite dimensional normed spaces and subspaces and also to identify selfadjoint transformations	1		2	2	3				2			2	1	3
						CO2	Apply the spectral theorem and orthogonal decomposition of inner product spaces, the Jordan canonical form to solving systems of ordinary differential equations			1	2	2	3	2		2			2	1	3
						CO3	This course covers major theorems of Functional Analysis that have applications in Ordinary and Partial Differential Equations. Review of linear spaces and their norms. The Hahn-Banach, Baire Category, Uniform Boundedness Principle, Open Mapping and Closed Graph theorems.			2	1	2	3						2	1	2
						CO4	Apply various methods in real life problems	1			2		2	3			3	2		2	1
Partial Differential Equations	MMATI-418	4	4	6	400	CO1	Apply a range of techniques to solve first & second order partial differential equations.			1	2	3			2				2	2	2
						CO2	Model physical phenomena using partial differential equations such as the heat and wave equations.			1	2	2	3	2		2			2	2	3

Advanced Operations Research	MMAT1-458	4	4	60	400	CO1	Formulate mathematical models involving Queuing theory and inventory problems from its physical considerations.		1	3								1	1	1		
						CO2	Apply the knowledge of mathematical techniques in order to get the solution of Queuing and inventory models.		2			2	1	2					1	2	2	
						CO3	Continue to acquire the knowledge and skills of mathematical modelling involving the problems of replacement and maintenance of equipment.		1			2		2						1	2	2
						CO4	Understand the formulation and use of networks for the solution of the maximal flow problem, the shortest-path problem and the minimal spanning tree problem.			3		2		2		1				1	2	1
Advanced Complex Analysis	MMAT1-459	4	4	60	400	CO1	Manipulate complex numbers in various representations.	2	3		1	2						3	2			
						CO2	Define and calculate limits and derivatives of functions of a complex variable. State and prove fundamental results, including: Cauchy's Theorem and Cauchy's Integral Formula		3	2	2	2		2					2	1		
						CO3	Understanding Geometrical interpretation of Complex functions		2		3	1	2							2	1	
						CO4	Understand Fundamental Theorem of Algebra, Morera's Theorem and		2		3	1	2							2	2	

							Liouville's Theorem and use them to prove related results.																	
Fractional Calculus	MMATI-460	4	4	60	400	CO1	Apply the knowledge to evaluate fractional integrals of some common functions by understanding the Riemann-Liouville fractional integral	2	2					2			1			1	1	1		
						CO2	Define the Leibniz's formula of fractional derivatives and find the fractional derivatives of some common functions	2	2						1						1		1	
						CO3	Develop the skills to solve the linear fractional differential equations using the Laplace transform.	2	1					2	2	1		2			1			1
						CO4	Introduce the Leibniz formula for Weyl fractional integral and investigate some applications of the fractional calculus to the real world.		2					1	2	2		2				1	1	1
Graph Theory	MMATI-461	4	4	60	400	CO1	Define the basic concept of graphs, its types and properties		2	3						2				3				
						CO2	Define the properties of trees, and to understand the concept of colouring and theory	3	1							2					2	2	1	
						CO3	Understand Eulerian and Hamiltonian graphs with results.		2	3		2					1				1			2
						CO4	Understand the connectivity and paths, edges and cycles.		2	3			3				1					2		
Sampling Distribution and Estimation	MMATI-462	4	4	60	400	CO1	Understand the idea of Sampling and its types, to know the concept of Estimation Theory,				2	1	2		1					1				

						CO2	Identify emerging technologies for use in business applications.	1	1	2	1	2	1	2	3	3	3	3	2	1	2	2		
						CO3	Demonstrate basic skills involving spreadsheet functions; create formulas, charts, and graphs; manipulate data; and generate reports	1	1	2	2	2	2	2	3	3	3	3	2	1	2	2		
						CO4	Gain an education for office careers by focusing on developing communication skills as well as skills in office technology systems.	1	1	2	2	2	2	2	3	3	3	3	2	1	2	2		
Business Ethics	MBAD0-F97	4	3	4	0	300	CO1	Understand role the ethics and values in Business.							3				1		1			
							CO2	Understand role the ethics in functioning of various departments of organization like Marketing, Finance & HR.								1				2	1			
							CO3	Analyze the ethics in society and Business.					1	1	1	2								
							CO4	Implement Individual & Group policies and laws of ethics.									2		1	2				

Enter Correction levels 1, 2 or 3 as defined below:

1. Slight (Low) - upto 30% 2. Moderate (Medium) –above 30% and upto 70% 3. Substantial (High) – above 70%