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: **DEPARTMENT OF MATHEMATICS**
MRSPTU MAIN CAMPUS ,BATHINDA

Program: M.Sc (2016)

COs, POs, PSOs Mapping

Subject: Abstract Algebra	**Subject Code:** MMAT1-101	**Semester:** **1st**
Credit: **4**	**L T P 4 0 0**	**Duration:** **45Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	

Subject: Real Analysis	**Subject Code:** MMAT1-102	**Semester:** **1st**
Credit: 4	**L T P 4 0 0**	**Duration: 45Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

Subject: Mechanics	**Subject Code:** MMAT1-103	**Semester:** **1st**
Credit: 4	**L T P 4 0 0**	**Duration: 45Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Use of the Lagrange's equation for deriving equation of motions		2			2	1	2		2				2	3	1
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

Subject: Differential equations	**Subject Code:** MMAT1-104	**Semester:** **1st**
Credit: **4**	**L T P** **4 0 0**	**Duration:** **45Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	
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

Subject: Fundamentals of Computer and C Programming	**Subject Code:** MCAP0-193	**Semester:** **1st**
Credit: **4**	**L T P** **4 0 0**	**Duration:** **45Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	3	3	3	3	2	1	2	2
CO3	Understand the fundamentals of hardware, software,	1	1	1	2	2	2	2	3	3	3	3	2	1	2	2

	and programming.															
CO4	Understand the logic building used in Programming	1	1	1	2	2	2	2	3	3	3	3	2	1	2	2

Subject: Fundamentals of Computer and C Programming Lab	**Subject Code:** MCAP0-194	**Semester:** **1st**
Credit: **1**	**L T P** **0 0 2**	**Duration:** **60Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	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	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	3	3	3	3	2	1	2	2

Subject: Advanced Algebra	**Subject Code:** MMAT1-205	**Semester:** **2nd**
Credit: **4**	**L T P** **4 0 0**	**Duration:** **45Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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 GaloisTheory.	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

Subject: Measure Theory and Integration	**Subject Code:** MMAT1-206	**Semester:** **2nd**
Credit: **4**	**L T P 4 0 0**	**Duration:** **45Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

Subject: Complex Analysis	**Subject Code:** MMAT1-207	**Semester:** **2nd**
Credit: **4**	**L T P 4 0 0**	**Duration:** **45Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	

Subject: Tensor and Differential Geometry	**Subject Code:** MMAT1-208	**Semester:** **2nd**
Credit: **4**	**L T P** **4 0 0**	**Duration:** **45Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

Subject: Numerical Analysis	**Subject Code:** MMAT1-209	**Semester:** **2nd**
Credit: **4**	**L T P** **4 0 0**	**Duration:** **45Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	1	1		1	1	1			3				2	1	2

	of problems related to initial and boundary value problems of ordinary differential equations etc.															

Subject: Numerical Analysis lab	**Subject Code:** MMAT1-210	**Semester:** **2nd**
Credit: **1**	**L T P 0 0 2**	**Duration:** **30Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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 problem efficiently.		2	2		2	2	3		2	1			1	2	2
CO4	Develop understanding of numerical error and applicability of a particular method		1	2		1	1	3		3	2			2		2

Subject: Topology	**Subject Code:** MMAT1-311	**Semester:** **3rd**
Credit: **4**	**L T P 4 0 0**	**Duration:** **45Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	3

Subject: Operations research	**Subject Code:** MMAT1-312	**Semester:** **3rd**
Credit: **4**	**L T P 4 0 0**	**Duration:** **45Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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 and assignment problems.						1		2		2			1	1	1
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

Subject: Mathematical Statistics	**Subject Code:** MMAT1-313	**Semester:** **3rd**

Credit: 4	**L T P** 4 0 0	**Duration:** 45Hrs.

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

Subject: Mathematical Methods	**Subject Code:** MMAT1-314	**Semester:** 3rd
Credit: 4	**L T P** 4 0 0	**Duration:** 45Hrs.

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

Subject: Seminar-I	**Subject Code:** MMAT1-315	**Semester:** <u>**3rd**</u>
Credit: <u>**1**</u>	**L T P** <u>**0 0 2**</u>	**Duration:** <u>**30Hrs.**</u>

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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		2

Subject: Fourier Analysis and Applications	**Subject Code:** MMAT1-356	**Semester:** <u>**3rd**</u>
Credit: <u>**4**</u>	**L T P** <u>**4 0 0**</u>	**Duration:** <u>**45Hrs.**</u>

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	Able to have knowledge about Discrete Fourier transforms Fast Fourier transforms and their use in technology		2		2	2								2	2	

Subject: Advanced Numerical Analysis	**Subject Code:** MMAT1-357	**Semester:** **3rd**
Credit: **4**	**L T P 4 0 0**	**Duration:** **45Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

Subject: Number Theory	**Subject Code:** MMAT1-416	**Semester:** **4th**
Credit: **4**	**L T P 4 0 0**	**Duration:** **45Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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 $\varphi(n)$, Mangolt function $\Lambda(n)$, Liouvilles function, The divisor function and prime- factorization.		2	1			2	1								
CO3	Derive Euler Summation formula, Dirichlet inversion formula, Mobius inversion formula.		2				1	3								2
CO4	Familiar with elementary theorems on Distribution of prime numbers,Dirichlet character.			1		1	2	2						2		2

Subject: Functional Analysis	**Subject Code:** MMAT1-417	**Semester:** 4th
Credit: 4	**L T P** 4 0 0	**Duration:** 45Hrs.

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	2

Subject: Partial Differential Equations	**Subject Code:** MMAT1-418	**Semester:** 4th
Credit: 4	**L T P** 4 0 0	**Duration:** 45Hrs.

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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
CO3	Recognize the major classification of PDEs and the			1		2	3							2	1	2

	qualitative differences between the classes of equations.															
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			3	2		2	2	2

Subject: Seminar-II	**Subject Code:** MMAT1-419	**Semester:** **4th**
Credit: **1**	**L T P** **0 0 2**	**Duration:** **30Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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		2

Subject: Advanced Operations Research	**Subject Code:** MMAT1-458	**Semester:** **4th**
Credit: **4**	**L T P** **4 0 0**	**Duration:** **45Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Formulate mathematical models involving Queuing theory and inventory problems from its physical considerations.		1	3							1			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

Subject: Advanced Complex Analysis	**Subject Code:** MMAT1-459	**Semester:** <u>4th</u>
Credit: <u>4</u>	**L T P** <u>4 0 0</u>	**Duration:** <u>45Hrs.</u>

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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 Liouville's Theorem and use them to prove related results.		2			3	1	2						2	2	

Subject: Fractional Calculus	**Subject Code:** MMAT1-460	**Semester:** <u>4th</u>
Credit: <u>4</u>	**L T P** <u>4 0 0</u>	**Duration:** <u>45Hrs.</u>

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

Subject: Graph Theory	**Subject Code:** MMAT1-461	**Semester:** **4th**
Credit: **4**	**L T P 4 0 0**	**Duration:** **45Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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		2

Subject: Sampling Distribution and Estimation Theory	**Subject Code:** MMAT1-462	**Semester:** **4th**
Credit: **4**	**L T P** **4 0 0**	**Duration:** **45Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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		
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

Subject: Fuzzy Set Theory and Applications	**Subject Code:** MMAT1-463	**Semester:** **4th**
Credit: **4**	**L T P** **4 0 0**	**Duration:** **45Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Identify fuzzy sets and perform set operations.		2		2	2				1	1			3		1
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

Subject: Computer Application in Business	**Subject Code:** MCAP0-F91	**Semester:** **4th**
Credit: **3**	**L T P** **3 0 0**	**Duration:** **40Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	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

Subject: Business Ethics	**Subject Code:** MBAD0-F97	**Semester:** **4th**
Credit: **3**	**L T P** **3 0 0**	**Duration:** **40Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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			

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: **DEPARTMENT OF MATHEMATICS**
MRSPTU MAIN CAMPUS ,BATHINDA

Program: M.Sc (2019)

COs, POs, PSOs Mapping

Subject: Abstract Algebra	**Subject Code:** MMAT1-101	**Semester: 1st**
Credit: 4	**L T P 4 0 0**	**Duration: 60Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	

Subject: Real Analysis	**Subject Code:** MMAT1-102	**Semester:** **1st**
Credit: **4**	**L T P** **4 0 0**	**Duration:** **60Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

Subject: Mechanics	**Subject Code:** MMAT1-103	**Semester:** **1st**
Credit: **4**	**L T P** **4 0 0**	**Duration:** **60Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Use of the Lagrange's equation for deriving equation of motions		2			2	1	2		2				2	3	1
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

Subject: Differential equations	**Subject Code:** MMAT1-104	**Semester:** **<u>1st</u>**
Credit: **<u>4</u>**	**L T P <u>4 0 0</u>**	**Duration:** **<u>60Hrs.</u>**

COs	**Statement**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
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	
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

Subject: Fundamentals of Computer and C Programming	**Subject Code:** MCAP0-193	**Semester:** **<u>1st</u>**
Credit: **<u>4</u>**	**L T P <u>4 0 0</u>**	**Duration:** **<u>60Hrs.</u>**

COs	**Statement**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
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	3	3	3	3	2	1	2	2
CO3	Understand the fundamentals of hardware, software,	1	1	1	2	2	2	2	3	3	3	3	2	1	2	2

	and programming.															
CO4	Understand the logic building used in Programming	1	1	1	2	2	2	2	3	3	3	3	2	1	2	2

Subject: Fundamentals of Computer and C Programming Lab	**Subject Code:** MCAP0-194	**Semester:** **1st**
Credit: **1**	**L T P** **0 0 2**	**Duration:** **30Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	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	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	3	3	3	3	2	1	2	2

Subject: Advanced Algebra	**Subject Code:** MMAT1-205	**Semester:** **2nd**
Credit: **4**	**L T P** **4 0 0**	**Duration:** **60Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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 GaloisTheory.	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

Subject: Measure Theory and Integration	**Subject Code:** MMAT1-206	**Semester:** 2nd
Credit: 4	**L T P** 4 0 0	**Duration:** 60Hrs.

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

Subject: Complex Analysis	**Subject Code:** MMAT1-207	**Semester:** 2nd
Credit: 4	**L T P** 4 0 0	**Duration:** 60Hrs.

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	

Subject: Tensor and Differential Geometry	**Subject Code:** MMAT1-208	**Semester:** 2nd
Credit: 4	**L T P** 4 0 0	**Duration:** 60Hrs.

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

Subject: Numerical Analysis	**Subject Code:** MMAT1-209	**Semester:** 2nd
Credit: 4	**L T P** 4 0 0	**Duration:** 60Hrs.

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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,	2	2		2	2	2			2				2	1	1

	numerical differentiation and integration															
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

Subject: Numerical Analysis lab	**Subject Code:** MMAT1-210	**Semester:** 2nd
Credit: 1	**L T P** 0 0 2	**Duration:** 30Hrs.

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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 problem efficiently.		2	2		2	2	3		2	1			1	2	2
CO4	Develop understanding of numerical error and applicability of a particular method		1	2		1	1	3		3	2			2		2

Subject: Topology	**Subject Code:** MMAT1-311	**Semester:** 3rd
Credit: 4	**L T P** 4 0 0	**Duration:** 60Hrs.

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	3

Subject: Operations research	**Subject Code:** MMAT1-312	**Semester:** 3rd
Credit: 4	**L T P** 4 0 0	**Duration:** 60Hrs.

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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 and assignment problems.						1		2		2			1	1	1
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

Subject: Mathematical Statistics	**Subject Code:** MMAT1-313	**Semester:** 3rd
Credit: 4	**L T P** 4 0 0	**Duration:** 60Hrs.

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

Subject: Mathematical Methods	**Subject Code:** MMAT1-314	**Semester:** <u>**3^{rd}**</u>
Credit: <u>**4**</u>	**L T P** <u>**4 0 0**</u>	**Duration:** <u>**60Hrs.**</u>

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

Subject: Seminar-I	**Subject Code:** MMAT1-315	**Semester:** **3rd**
Credit: **1**	**L T P** **0 0 2**	**Duration:** **30Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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		2

Subject: Fourier Analysis and Applications	**Subject Code:** MMAT1-356	**Semester:** **3rd**
Credit: **4**	**L T P** **4 0 0**	**Duration:** **60Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	Able to have knowledge about Discrete Fourier transforms Fast Fourier transforms and their use in technology		2		2	2								2	2	

Subject: Advanced Numerical Analysis	**Subject Code:** MMAT1-357	**Semester:** 3rd
Credit: 4	**L T P** 4 0 0	**Duration:** 60Hrs.

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

Subject: Number Theory	**Subject Code:** MMAT1-416	**Semester:** 4th
Credit: 4	**L T P** 4 0 0	**Duration:** 60Hrs.

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Define divisibility, greatest common divisor, Prime numbers, congruence,					1	2								2	
CO2	Understand the concept of Mobius function μ(n), The Euler totient function φ(n), Mangolt function Λ (n), Liouvilles function, The divisor function and prime- factorization.		2	1			2	1								
CO3	Derive Euler Summation formula, Dirichlet inversion formula, Mobius inversion formula.		2				1	3								2
CO4	Familiar with elementary theorems on Distribution of prime numbers,Dirichlet character.			1		1	2	2						2		2

Subject: Functional Analysis	**Subject Code:** MMAT1-417	**Semester:** **4th**
Credit: **4**	**L T P 4 0 0**	**Duration:** **60Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	2

Subject: Partial Differential Equations	**Subject Code:** MMAT1-418	**Semester:** **4th**
Credit: **4**	**L T P 4 0 0**	**Duration:** **60Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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
CO3	Recognize the major classification of PDEs and the			1		2	3							2	1	2

	qualitative differences between the classes of equations.															
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			3	2		2	2	2

Subject: Seminar-II	**Subject Code:** MMAT1-419	**Semester:** **4th**
Credit: **1**	**L T P** **0 0 2**	**Duration:** **30Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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		2

Subject: Advanced Operations Research	**Subject Code:** MMAT1-458	**Semester:** **4th**
Credit: **4**	**L T P** **4 0 0**	**Duration:** **60Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Formulate mathematical models involving Queuing theory and inventory problems from its physical considerations.		1	3							1			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

Subject: Advanced Complex Analysis	**Subject Code:** MMAT1-459	**Semester:** 4th
Credit: 4	**L T P** 4 0 0	**Duration:** 60Hrs.

COs	**Statement**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
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 Liouville's Theorem and use them to prove related results.		2			3	1	2						2	2	

Subject: Fractional Calculus	**Subject Code:** MMAT1-460	**Semester:** 4th
Credit: 4	**L T P** 4 0 0	**Duration:** 60Hrs.

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

Subject: Graph Theory	**Subject Code:** MMAT1-461	**Semester:** **4th**
Credit: **4**	**L T P 4 0 0**	**Duration:** **60Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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		2

Subject: Sampling Distribution and Estimation Theory	**Subject Code:** MMAT1-462	**Semester:** **4th**

Credit: **4**	**L T P** **4 0 0**	**Duration:** **60Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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		
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

Subject: Fuzzy Set Theory and Applications	**Subject Code:** MMAT1-463	**Semester:** **4th**
Credit: **4**	**L T P** **4 0 0**	**Duration:** **60Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Identify fuzzy sets and perform set operations.		2		2	2				1	1			3		1
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

Subject: Computer Application in Business	**Subject Code:** MCAP0-F91	**Semester:** **4th**
Credit: **3**	**L T P** **3 0 0**	**Duration:** **40Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	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

Subject: Business Ethics	**Subject Code:** MBAD0-F97	**Semester:** **4th**
Credit: **3**	**L T P** **3 0 0**	**Duration:** **40Hrs.**

COs	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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% andupto70% 3. Substantial (High) – above 70%