GOVERNMENT ARTS COLLEGE (AUTONOMOUS)

KUMBAKONAM 612 002

Re - accredited With 'A' Grade by NAAC & Affiliated to Bharathidasan University

DEPARTMENT OF MATHEMATICS

(Effective for those admitted from 2020-2021 onwards)

SYLLABI

M.Sc., MATHEMATICS

Government Arts College(Autonomous)

Kumbakonam

Department of Mathematics

Syllabi for M.Sc. Mathematics

Under choice Based Credit System

(For students admitted from 2020 onwards)

MISSION STATEMENT

M.Sc. Mathematics

Mathematics is the queen of science and it has been applied to various branches of science since more of years. Apart from theoretical Mathematics, Logic, Geometry and Number theory, the applications of Mathematics have been significant in physics since many decades. But the trend nowadays is fast changing and its presence is felt much in physical sciences, Management studies, Computer networking, Economics and Biology. The aim of the course is to introduce both Pure and Applied Mathematics for students and it will motivate them to utilize in Computer applications. The students can choose any of these branches in Mathematics to pursue research work. The students of Mathematics with sharpened skills and techniques will find no difficulty in understanding and solving issues in everyday life and in administration.

M.Sc. Mathematics

Vision:

To produce disciplined, Socially committed and technically competent mathematicians through quality education and research.

Mission:

1. Imparting learners with knowledge on mathematics by developing suitable syllabi under CBCS system.
2. Strengthening the knowledge of mathematical concepts using models, softwares and ICT enabled teaching.
3. Motivating the learners to undertake research career.
4. Developing self confidence among the learners by sharpening their soft skills.
5. Inculcating social responsibilities among learners through extension activities.

Programme Name : M.Sc Mathematics

Programme outcomes:

2. Apply the knowledge of Mathematics in all relevant fields.
3. Identify challenging problems in mathematics and find appropriate solutions.
4. Explore the ideas of mathematics for propagation of knowledge and effective communications.
5. Gain the ability to understand the abstract concepts and apply it to the real life problems.
6. Create awareness to become an enlightened citizen with commitment to deliver the responsibilities within the scope.

Programme Specific Outcomes:

1. Pursue research in pure and applied mathematics.
2. Acquire deep knowledge in mathematics and computational skills so that they can quality NET/SET/GATE examinations.
3. Convert the real-world problems in to mathematical models and draw the inferences by finding appropriate solutions.
4. Inculcate mathematical reasoning and analytical skills.
5. Understanding of the fundamental axioms in mathematics and to develope capability of developing ideas based on them.

Government Arts College (Autonomous), Kumbakonam
Department of Mathematics
Syllabus Pattern For M.Sc. Mathematics
Under Choice Based Credit System
(For Students Admitted from 2020 onwards)

No.	Subject Code	Core/Elective	Subject	Hours	Credit	Marks
SEMESTER – I						
1	20P1M1	Core I	Algebra	6	4	100
2	20P1M2	Core II	Real Analysis	6	4	100
3	20P1M3	Core III	Ordinary Differential Equations	6	4	100
4	20P1M4	Core IV	Stochastic Processes	6	4	100
5	20P1M5	Core V	Methods of Applied Mathematics	6	4	100
			Total	**30**	**20**	**500**
SEMESTER – II						
6	20P2M6	Core VI	Linear Algebra	6	5	100
7	20P2M7	Core VII	Complex Analysis	6	5	100
8	20P2M8	Core VIII	Programming in C++	6	4	100
9	20P2M9EC	Elective I	Classical Dynamics/ Fractional Calculus/ Partial Differential Equations/ Advanced Algebra	6	5	100
10	20P2M10EC	Elective II	Classical Dynamics/ Fractional Calculus /Partial Differential Equations/ Advanced Algebra	6	5	100
			Total	**30**	**24**	**500**
SEMESTER – III						
11	20P3M11	Core IX	Topology	6	5	100
12	20P3M12	Core X	Differential Geometry	6	5	100
13	20P3M13	Core XI	Practicals in Mathematica	6	4	100
14	20P3M14EC	Elective III	Graph Theory/ Optimization Techniques/ Mathematical models in biology and medicine	6	5	100
15	20P3M15EC	Elective IV	Graph Theory/ Optimization Techniques/ Mathematical models in biology and medicine	6	5	100
			Total	**30**	**24**	**500**

SEMESTER – IV						
16	20P4M16	Core XII	Functional Analysis	6	5	100
17	20P4M17	Core XIII	Measure Theory And Integration	6	5	100
18	20P4M18	Core XIV	Number Theory	6	4	100
19	20P4M19EC	Elective V	Probability and Statistics/ Combinatorics	6	4	100
20	20P4MPW		Project work		4	100
			Total	**30**	**22**	**500**
			Grand Total	**120**	**90**	**2000**

Government Arts College (Autonomous), Kumbakonam
PG and Research Department of Mathematics

***Question Paper Pattern* for UG (2020 Onwards)**

PART – A To answer TEN questions	10 x 2 = 20 marks
PART – B To answer FIVE questions (either or type)	5 x 5 = 25 marks
PART – C To answer THREE questions (out of Five)	3 x10 = 30 marks
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SE	75 marks
CIA	25 marks

TOTAL	100 marks

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SEMESTER - I

CC 1 - ALGEBRA

Subject Code: 20P1M1	Credits: 4	External Marks: 75	Hours:6

OBJECTIVES*:*

To enable the students to

1. Acquire the strong foundation in the abstract approach.
2. Explore foundations of Algebraic structures such as, Groups, Rings, Fields, Dual spaces etc…
3. Learn a good mathematical maturity and to build mathematical thinking.
4. Aware of the applicability of abstract mathematics in real world problems.

UNIT I: **GROUP THEORY:** Another Counting principle- Sylow's theorem.

UNIT II: **RING THEORY:** More Ideals and Quotient Rings – The Field of Quotients of an integral domain – Euclidean rings – A Particular Euclidean Ring.

UNIT III: **POLYNOMIAL RINGS:** Polynomial Rings – Polynomials over the rational field – Polynomial rings over commutative rings.

UNIT IV: Dual spaces -inner product space – modules.

UNIT V: Extension Fields - Roots of Polynomials – More about roots.

TEXT BOOK: I. N. Herstein, Topics in Algebra, 2nd Edition, John Wiley & Sons Publications, 2004.

UNIT I : Chapter 2: 2.11 & 2.12
UNIT II : Chapter 3: 3.5 to 3.8
UNIT III : Chapter 3: 3.9 to 3.11
UNIT IV : Chapter 4: 4.3 & 4.5 and Chapter 5: 5.1
UNIT V : Chapter 5: 5.3, 5.5 & 5.6

REFERENCES:

1. John B. Fraleigh, A first course in Abstract Algebra, Pearson Education India, 2003.
2. A.R.Vashishtha and A.K. Vashishtha, Modern Algebra, Krishna Prakashan medis P.Ltd Meerut, 2014.

COURSE OUTCOMES:

After the completion of this course, the students will be able to

1. Acquire the knowledge of Algebra to attain a good mathematical maturity and to build mathematical thinking and skill.
2. Understand sylow's theorem and its applications.
3. Create, select and apply appropriate algebraic structures such as finitely generated abelian groups, rings, ideals, fields to explore the existing results.
4. Apply the concepts of Vector Spaces and Dual spaces to physical problems.
5. Learn the applications of Group structures in coding theory and cryptography.

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	√		√	√	√	√	√	√	√	√
CO2		√		√		√	√	√	√	√
CO3	√	√	√	√		√	√	√	√	√
CO4		√	√			√	√	√	√	√
CO5	√		√			√	√		√	√

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SEMESTER - I
CC 2 - REAL ANALYSIS

Subject Code: 20P1M2	Credits: 4	External Marks: 75	Hours: 6

OBJECTIVES:

To enable the students to

1. Provide a Comprehensive idea about the principles of real analysis.
2. Understand the concepts of Metric Spaces, Continuity, Differentiation and Riemann Stieltjes Integrals.
3. Develop the right approach towards research in analysis**.**
4. Enhance the ability of thinking in Real Analysis.

UNIT I: **BASIC TOPOLOGY** : Finite, countable and uncountable sets - metric Spaces - Compact sets –perfect sets - connected sets.

UNIT II: **Continuity:** Limits of Functions – Continuous Functions – Continuity and Compactness – Continuity and Connectedness – Discontinuities – Monotonic functions.
Differentiation: The derivative of a real function – Mean value theorems – Continuity of derivatives – L' Hospital's Rule – Taylor's Theorem.

UNIT III: **RIEMANN – STIELTJES INTEGRALS** :Definition and existence of the integral – properties of the integral - Integration and differentiation- Integration of vector valued functions – Rectifiable curves.

UNIT IV: **SEQUENCES AND SERIES OF FUNCTIONS:** Uniform convergence – Uniform convergence and Continuity – Uniform Convergence and integration – Uniform Convergence and differentiation - Equicontinuous families of functions – The Stone-Weierstrass theorem.

UNIT V: **FUNCTIONS OF SEVERAL VARIABLES:** Functions of several variables: Linear Transformations - Differentiation – The Contraction Principle – The Inverse Function Theorem - The Implicit Function Theorem.

TEXT BOOK: Walter Rudin , Principles Of Mathematical Analysis , III Edition, Mc Graw Hill Publishing Company, 1976.

UNIT I : Chapter 2
UNIT II : Chapter 4 and 5 (omit 5.16 to 5.19)
UNIT III : Chapter 6
UNIT IV : Chapter 7: Section 7.7 to 7.27
UNIT V : Chapter 9 : Section 9.1 to 9.29

REFERENCES:

1. T. M. APOSTOL , Mathematical Analysis, II Edition, Addision Wesley,1996.
2. H. L. ROYDEN, Real Analysis, Mac millan II Edition,1968.

COURSE OUTCOMES:

After the completion of this course, the students will be able to

1. Understand the basic ideas of the real line R and its properties, also their behaviors such as countability, uncountability of compactness and connectedness.
2. Know the concepts of limits, continuity, discontinuity and derivative of real functions.
3. Use the theory of Riemann-Stieltjes integrals in solving definite integrals.
4. Learn the concepts of convergence, divergence, uniform convergence of sequence and series.
5. Extend the knowledge of real variables for further exploration of several variables.

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	√		√	√	√	√	√	√	√	√
CO2	√	√	√			√	√		√	√
CO3	√	√				√	√	√	√	
CO4	√	√		√		√	√		√	√
CO5	√	√		√		√	√	√	√	

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SEMESTER - I
CC 3 - ORDINARY DIFFERENTIAL EQUATIONS

Subject Code: 20P1M3	Credits: 4	External Marks: 75	Hours: 6

OBJECTIVES:

To enable the Students to

1. Introduce ordinary differential equations and fundamental theorem for existence and uniqueness.
2. Learn analytic techniques for computing solution of various ordinary differential equations with and without initial and boundary conditions.
3. Explore the use of series methods about ordinary and regular-singular points.
4. Understand the various cases of critical points.
5. Study the existence, uniqueness, stability behavior of the solutions of the ODE.

UNIT I: The general solution of the homogeneous equation–the use of a known solution to find another - the method of variation of parameters–series solutions of first order equations.

UNIT II: Second order linear equations – ordinary points - Regular singular points - regular singular points(continued) – Gauss's Hyper geometric equation – Legendre polynomials – properties of Legendre Polynomials.

UNIT III: Bessel functions – Gamma functions – Properties of Bessel functions – System of first order equation : Linear system – Homogeneous linear system with constant co-efficients.

UNIT IV: Oscillation Theory and Boundary value problems :Qualitative Properties of Solutions– The Sturm Comparison Theorem – Eigen values, Eigen functions and the Vibrating String.

UNIT V: Critical points and stability for linear systems –Stability by Liapunov's direct method – Simple critical points of nonlinear systems.

TEXT BOOK: George F. Simmons, Differential Equations with Application and Historical notes, second ediion, McGraw Hill Publishing Company, 2003.

UNIT I : Chapter 3 Sec15,16 19 ; Chapter 5 Sec 26;
UNIT II : Chapter 5 Sec 27 to 31; Chapter 8 sec44,45;
UNIT III : Chapter 8 Sec 46,47; Chapter 10 Sec 55,56;
UNIT IV : Chapter 4 Sec 24, 25; Chapter 7 Sec 40
UNIT V : Chapter 11Sec 60, 61, 62.

REFERENCES:

1. M.D.Raisinghania , Differential Equations, S .Chand and Co .Ltd., New Delhi, 2007.
2. W.T. Reid, Ordinary differential equations, John wiley & Sons, New York,1971.
3. E.A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, McGraw Hill Publishing Company, New York, 1955.

COURSE OUTCOMES:

After the completion of this course, the students will be able to

1. Develop skills to find solution of homogenous equations and second order linear equations.
2. Determine regions of the planes in which a given first-order differential equations will have a unique solution.
3. Obtain solutions for the system of ordinary differential equations and eigen value problems by using various tools of linear algebra.
4. Acquire the knowledge of Legendre polynomials and Bessels functions.
5. Understand oscillation theory and Boundary value problems.

OUTCOMES MAPPING:

Course Outcomes	*Programme Outcomes*					*Programme Specific Outcomes*				
	PO1	*PO2*	*PO3*	*PO4*	*PO5*	*PSO1*	*PSO2*	*PSO3*	*PSO4*	*PSO5*
CO1	√		√			√				√
CO2		√	√							
CO3			√	√				√	√	
CO4			√			√				
CO5	√		√			√				√

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SEMESTER - I
CC 4 - STOCHASTIC PROCESSES

Subject Code: 20P1M4	Credits: 4	External Marks: 75	Hours: 6

OBJECTIVES:

To enable the students to

1. Acquire the skill of advanced level of mathematical sophistication and enhancing the horizons of knowledge.
2. Apply Stochastic Models to various real life problems.
3. Extend the use of stochastic models in various areas..
4. Learn the idea of stochastic process and their classifications.

UNIT I: **STOCHASTIC PROCESSES: SOME NOTIONS:** Introduction – Specification of stochastic processes – Stationary processes

.

UNIT II: **MARKOV CHAINS:** Definition and examples – Higher transition probabilities- Generalization of independent Bernoulli trials: Sequence of chain dependent trials.

UNIT III: **MARKOV CHAINS CONTINUED:** Classification of states and chains – Determination of Higher transition probabilities – Stability of a Markov system – Markov chains with denumerable number of states – Reducible chains - Markov chains with continuous state space.

UNIT IV: **MARKOV PROCESSES WITH DISCRETE STATE SPACE:** Poisson process – Poisson process and related distributions.

UNIT V: **RENEWAL PROCESSES AND THEORY:** Renewal Process – Renewal Processes in continuous time – Renewal equation – Stopping time: Wald's equation - Renewal Theorems.

TEXT BOOK: J.Medhi, Stochastic Processes, second edition, New age International(P) limited Publishers, New Delhi, 1994.

UNIT I : Chapter 2: 2.1 to 2.3
UNIT II : Chapter 3: 3.1 to 3.3
UNIT III : Chapter 3: 3.4 to 3.6, 3.8, 3.9, 3.11
UNIT IV : Chapter 4: 4.1 to 4.2
UNIT V : Chapter 6: 6.1 to 6.5

REFERENCES:

1. S. Karlin and H. M. Taylor, A first Course in stochastic processes, Academic press, second edition, New York,2011.
2. S. M. Ross, Stochastic Processes, second edition, Wiley India Ltd, 2008.

COURSE OUTCOMES:

After the completion of this course, the students will be able to

1. Understand the stochastic models for many real life probabilistic situations.
2. Gain working knowledge to the problem of uncertainty..
3. Get a basic knowledge for doing research is this area.
4. Explain the concept of stationary and wide sense stationary and appreciate their significance.
5. Describe renewal process in continuous time using Wald's equation.

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	√		√		√		√		√	
CO2						√		√		√
CO3		√		√						
CO4			√			√	√	√		√
CO5	√		√			√	√	√		√

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SEMESTER - I
CC 5 - METHODS OF APPLIED MATHEMATICS

Subject Code: 20P1M5	Credits: 4	External Marks: 75	Hours: 6

OBJECTIVES:

To enable the students to

1. Acquire knowledge and develop interest in Applied Mathematics.
2. Know about Calculus of Variations.
3. Understand various methods involved in Fourier Transforms.
4. Solve integral and differential equations of Green's Functions.
5. Study Hilbert Schmidt theory.

UNIT I: **VARIATIONS PROBLEMS** : Maxima and Minima – The simplest case – Illustrative examples – Natural boundary conditions and transition conditions – The variational notation.

UNIT II: **GREEN'S FUNCTION** : Introduction – Relations between differential and integral equations – The Green's function – Fredholm equations with separable kernels – Illustrative example.

UNIT III: **HILBERT SCHMIDT THEORY** : Hilbert-Schmidt Theory – Iterative methods for solving equations of the second kind – The Neumann series – Fredholm theory – Singular Integral equations – Special devices.

UNIT IV: **FOURIER TRANSFORMS** : Inversion formula for complex Fourier transform – Fourie Cosine and Sine Transforms–linearity property – Change of scale property – Shifting property – modulation and Convolution theorems – problems.

UNIT V: **APPLICATIONS OF FOURIER TRANSFORM IN INITIAL AND BOUNDARY VALUE PROBLEMS** : Application of infinite Fourier transforms Choice of infinite sine or cosine transforms – Application of finite Fourier transforms – Finite Fourier transform of partial derivatives – Choice of finite sine or cosine transforms.

TEXT BOOKS:

1. Francis B. Hildebrand, Methods Of Applied Mathematics, Second Edition, Courier Corporation , 2012.
2. A.R. Vasista And R . K. Gupta , Integral Transforms, Krishna Prakashan Mandir Ltd, Krishna Educational Publishers, 2014.

UNIT I **:** Chapter 2 : 2.1 to 2.5 (Text book I)
UNIT II **:** Chapter 3 : 3.1 to 3.3 & 3.6 to 3.7 (Text book I)
UNIT III **:** Chapter 3 : 3.8 to 3.13 (Text book I)
UNIT IV **:** Chapter 6 :(All sections) (Text book II)
UNIT V **:** Chapter 8 :(All sections) (Text book II)

REFERENCES: Dr. J.K. Goyal And K.P. Gupta , Integral Transforms, Pragati Prakashan, Meerut ,2013

COURSE OUTCOMES:

After the completion of this course, the students will be able to

1. Understand different types of methods for solving given differential equations.
2. Know different integral equations and methods of solving them
3. Analyze variational problems with moving boundaries.
4. Understand the theory and applications of Fourier transforms and the properties of various kinds of integral equations.
5. Understand the applications of Fourier transform for initial and boundary value problems.

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	√						√			
CO2		√				√				
CO3			√					√		
CO4				√						√
CO5					√					√

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M.Sc., MATHEMATICS

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SEMESTER - II
CC6 - LINEAR ALGEBRA

Subject Code: 20P2M6	Credits: 5	External Marks: 75	Hours: 6

OBJECTIVES:

To enable the students to

1. Get into deeper insight in linear algebra.
2. Analyze and construct mathematical arguments that related to the study of linear algebra.
3. Understand the concepts of linear spaces, mapping between spaces, norm and the action on spaces.
4. Learn rudimentary things in developing matrix theory.
5. Acquire the knowledge on triangularization, diagonalization and primary decomposition theorem.

UNIT I: Linear transformations: Linear transformations -The algebra of linear Transformations –Isomorphism.

UNIT II: Representation of Linear Transformations by Matrices-Linear functionals- The double dual- The transpose of a linear transformation.

UNIT III: Polynomials: Algebras -The algebra of polynomials-Lagrange interpolation-Polynomial Ideals-the prime factorization of a polynomial.

UNIT IV: Determinants:Commutative rings- Determinant functions-Permutations and the uniqueness of determinants-Additional properties of determinants. Elementary canonical forms: Introduction - Characteristic values- Annihilating Polynomials.

UNIT-V: Invariant subspaces-Simultaneous triangularization and simultaneous diagonalization – Direct sum Decompositions -Invariant Direct Sums – The primary Decomposition theorem –.

TEXT BOOK: Kenneth Hoffman and Ray Kunze, Linear Algebra (Second Edition), prentice – Hall of India Private Limited, New Delhi 1971.

UNIT I : Chapter 3 (Sectin 3.1 to 3.3)
UNIT II : Chapter 3 (Section 3.4 to 3.7)
UNIT III : Chapter 4
UNIT IV : Chapter 5 (Section 5.1 to 5.4)6 (Section 6.1 to 6.3)
UNIT V : Chapter 6 (Section 6.4 to 6.8)

REFERENCES:

[1] Topics In Algebra , I. N. Herstein, Wiley Eastern Limited, New Delhi, 1975.
[2] I.S.Luther and I.B.S. Passi , Algebra Volume II, Rings,Narosa Publishing House, 1999.
[3] N.Jacobson Basic Algebra Volumes I& II , Freeman,1980.
(Also Published By Hindustan Publishing Company)

COURSE OUTCOMES:

After the completion of this course, the students will be able to

1. Understand and apply fundamental concepts of vector spaces, bases, dimension, linear transformations, polynomials and diagnolization.
2. Use matrix and vector algebra and related matrices to linear transformations.
3. Apply basic strategies of mathematical proof.
4. Identify and work with some historical and modern applications of linear algebra.
5. Strengthern mathematical reasoning, problem solving, algebraic and quantitative skills.

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	√			√		√				
CO2			√							√
CO3				√						
CO4				√				√		
CO5							√		√	

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SEMESTER - II

CC 7 - COMPLEX ANALYSIS

Subject Code: 20P2M7	Credits: 5	External Marks: 75	Hours: 6

OBJECTIVES:

To enable the students to

1. Understand the concepts of complex Analysis such as analytic functions, Cauchy Riemann relations and harmonic functions.
2. Acquire the Knowledge on contour integration to evaluate complicated real integrals via residue class.
3. Study the concepts of Residues to evaluate definite integrals.
4. Understand Convergence and divergence series of complex variable functions with special emphasis on Taylor and Laurent series.
5. Acquire the knowledge on harmonic functions and power series expansions.

UNIT I: **Analytic functions as mappings : Elementary Point Set Topology: Conformality:** Arcs and Closed Curves – Analytic Functions in Regions – Conformal Mapping – Length and Area; **Linear Transformations:** The Linear Group – The Cross Ratio – Symmetry.

UNIT II: **Complex integration: Fundamental Theorems**: Line Integrals – Rectifiable Arcs – Line Integrals as Functions of Arcs – Cauchy's Theorem for a Rectangle – Cauchy's Theorem in a Disk - Cauchy's Integral Formula**:** The Index of a Point with Respect to a Closed Curve – The Integral Formula – Higher Derivatives.

UNIT III: **Local Properties of Analytic Functions**: Removable Singularities - Taylor's Theorem – Zeros and Poles – The Local Mapping – The Maximum Principle.

UNIT IV: **The General Form of Cauchy's Theorem:** Chains and Cycles – Simple Connectivity –Homology – The General Statement of Cauchy's Theorem – Proof of Cauchy's Theorem– Locally Exact Differentials – Multiply Connected Regions; The Calculus of Residues**:** The Residue Theorem – The Argument Principle – Evaluation of Definite Integrals.

UNIT V: **Harmonic Functions:** Definition and Basic Properties – The Mean-value Property –Poisson's Formula – Schwarz's Theorem – The Reflection Principle; **Power series Expansions**: Weierstrass's Theorem – The Taylor Series – The Laurent Series.

TEXT BOOK: Lars V. Ahlfors, Complex Analysis, Third Ed. McGraw-Hill Book Company, Tokyo,1979.

UNIT – I Chapter 3: Sec 2 and Sec 3:3.1-3.3
UNIT – II Chapter4: Sec 1 and 2
UNIT – III Chapter 4: Sec 3
UNIT – IV Chapter 4: Sec 4 and 5
UNIT – V Chapter 4: Sec 6 and Chapter 5: Sec 1

REFERENCES:

1. Serge Lang, Complex Analysis, Addison Wesley, 1977.
2. S.Ponnusamy,Foundations of Complex Analysis, Narosa Publishing House, NewDelhi, 1997.
3. Karunakaran, Complex Analysis, Alpha Science international Ltd, Second edition, 2005.

COURSE OUTCOMES:

After the completion of this course, the students will be able to

1. Apply the concepts of analytical functions, Harmonic functions and explains the role of the Cauchy Riemann equations.
2. Use Cauchy integrals theorem, Cauchy integral formula and some of their consequences in various areas.
3. Develop the theory, methods and techniques of the course to solve mathematical problems .
4. Extend the study to advanced complex analysis.
5. Develop for further research aspects.

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1						√				
CO2	√						√			
CO3									√	
CO4		√		√					√	
CO5			√			√				√

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M.Sc., MATHEMATICS

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SEMESTER - II

CC 8 - PROGRAMMING IN C++

Subject Code: 20P2M8	Credits: 4	External Marks: 75	Hours: 6

OBJECTIVES:

To enable the students to

1. Understand the programming style that is associated with the concepts of class, objects and other concepts resolving around these two, like inheritance and polymorphism.
2. Understand the concept of constructors and distructors.
3. Explain the concepts of operators overloading, type casting operators, type conversions, pointers; pointers to desire object and classes, virtual functions and get complete programming knowledge.
4. Learn the concepts of structures and classes, static members with functions and array of objects.
5. Evolve from procedure oriented programmings to object oriented programming.

UNIT I: **Principles of object oriented programming :** Object oriented programming paradigm – Basic concepts of object oriented programming . **Beginning with C++: A**pplications of C++ - Structure of C++ program. **Tokens, Expressions and control structures:** Identifiers and constants – Declaration of variables.

UNIT II : **Functions in C++:** Function prototyping – Default arguments – Recursion - Function overloading – Friend and virtual functions – math library functions

UNIT III: **Classes and objects:** Defining member functions – Nesting member function – friendly functions – Local classes. **Constructors and destructors: C**onstructors –Constructors with default argument – Constructing two dimensional arrays – destructors.

UNIT IV: **Operator overloading and type conversions:** Defininig operator overloading –Overloading binary operators – Manipulation of strings using operators – Rules for overloading operators – Type conversions.

UNIT V : **Inheritance : Extending classes** –Defining derived classes – Multiple inheritance – abstract classes – Constructors in derived classes. **Pointers, virtual functions and polymorphisms:** Pointers – Pointers to derived objects – Pointers to derives classes - Virtual functions – virtual constructors and destructors.

TEXT BOOK: Balagurusamy.E , Object Oriented Programming With C++, Tata Mc Graw Hill Publishing Company Ltd, 1997.

UNIT I : Chapters 1 to 3
UNIT II : Chapter 4
UNIT III : Chapters 5 & 6
UNIT IV : Chapter 7
UNIT V : Chapters 8 & 9

REFERENCES:

1. Robert Lafore , Turbo C++, Galgotia Publications, 2007.
2. Stephen Prata, C++ Primer plus, Sixth edition, Addison Wesley Professional, 2011.

COURSE OUTCOMES:
After the completion of this course, the students will be able to

1. Understand the object oriented programs which contain both data and functions that act on that data and a class is a template for a number of objects.
2. Learn programming basics, viz., simple functions, call by value and reference, returning values of different type, function overloading, and recursive functions.
3. Apply the programming concepts of c++ for solving mathematical problems.
4. Realize object oriented programmings as a vast improvement over procedural programs.
5. Develope softwares for solving mathematical problems .

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	√	√				√				
CO2				√						√
CO3	√				√		√		√	
CO4			√		√					
CO5							√	√		

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M.Sc., MATHEMATICS

(Effective for those admitted from 2020-2021 onwards)

SEMESTER – II
ELECTIVE COURSE

EC- CLASSICAL DYNAMICS

Subject Code:	Credits: 5	External Marks: 75	Hours: 6

OBJECTIVES:

To enable the students to

1. Learn various fundamental concepts of mechanical systems like co-ordinates, constraints, etc.
2. Introduce various kinds of forces acting in a mechanical system.
3. Demonstrate the various kinds equation of motion of a system.
4. Explore the applications of Lagrange's equations and various functions.
5. Study the solution of equation of motion for a system and learn example Problems.

UNIT I: **Introductory concepts**: The mechanical systems - Generalized coordinates – Constraints – Virtual work.

UNIT II: **Energy and momentum**: **Lagrange's equations**: Derivation of Lagrange's Equations –Examples.

UNIT III: **Integrals of the motion**: Special applications of Lagrange's Equations – Rayleigh's Dissipation function.

UNIT IV: **Impulsive motion and Hamilton's equations**: Hamilton's Principle – Hamilton's Equations.

UNIT V: **Other variational Principles** : Hamilton's Principles Function – The Hamilton -Jacobi Equation – Separability.

TEXT BOOK: Donald T. Greenwood**,** Classical Dynamics, Dover publications, INC., 1977.

UNIT I : Chapter 1: 1.1 to 1.4
UNIT II : Chapter 1: 1.5 & Chapter 2: 2.1,2.2
UNIT III : Chapter 2: 2.3 & Chapter 3: 3.1
UNIT IV : Chapter 3: 3.2 & Chapter 4: 4.1 & 4.2
UNIT V : Chapter 4: 4.3 & Chapter 5: 5.1 to 5.3.

REFERENCES:

1. H.Goldstein, Classical Mechanics(Second Edition), Narosa Publishing House, New Delhi,1998.
2. Narayan Chandra Rana and Promod Sharad Chandra Joag, Classical Mechanics, Tata Mc Graw Hill,1991.

COURSE OUTCOMES:

After the completion of this course, the students will be able to

1. Understand the basic concepts and various principles of a mechanical system.
2. Learn various functions like Lagrange's, Hamiltonian's, Rayleigh's functions on mechanical systems.
3. Understand the derivations of Lagrange's , Hamiltonian- Jacobi equations.
4. Study the motion of various mechanical systems.
5. Solve the integrals or solutions of equation of motions.

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	√	√				√				
CO2			√				√			√
CO3				√			√	√		
CO4	√					√				
CO5		√		√		√				√

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SEMESTER – II
ELECTIVE COURSE

EC - PARTIAL DIFFERENTIAL EQUATIONS

Subject Code:	Credits: 5	External Marks: 75	Hours:6

OBJECTIVES:

To enable the students to

1. Study first, second and higher order partial differential equations and their classifications.
2. Learn second and higher order partial differential equations in physics.
3. Study analytic methods for computing solutions of various partial differential equations.
4. Acquire in applications of partial differential equations which appear in real life and physical phenomena like wave equation of string, diffusion equations and heat flow equations etc.
5. Solve Laplace equations which may be solved by applications of special functions.

UNIT I: **Partial differential equations of the first order :**Partial differential equations- origins of first order partial differential equations-Cauchy's problem for first order equations- Linear equations of the first order-integral surfaces passing through a given curve- surfaces orthogonal to a given system of surfaces -Nonlinear partial differential equations of the first order.

UNIT II: Compatible systems of first order equations-Charpit's method- Special types of first order equations- Solutions satisfying given conditions-Jacobi's method.

UNIT III: **Partial differential equations of the second order :** The origin of second order equations–second order equations in physics – Higher order equations in physics - Linear partial differential equations with constant co-efficients - Equations with variable coefficients-characteristic curves of second order equations

UNIT IV: Characteristics of equations in three variables- The solution of linear hyperbolic equations- Separation of variables - The method of integral transforms – Non linear equations of the second order.

Unit V: **Laplace's equation :** Elementary solutions of Laplace's equations-families of equipotential Surfaces- Boundary value problems-Separation of variables –Problems with axial symmetry.

TEXT BOOK: Ian N. Sneddon, Elements of Partial differential equations**,** Dover Publication –INC, New York, 2006.

UNIT I : Chapter II Sections 1 to 7
UNIT II : Chapter II Sections 9 to 13
UNIT III : Chapter III Sections 1 to 6
UNIT IV : Chapter III Sections 7 to 11
UNIT V : Chapter IV Sections 2 to 6

REFERENCES:

1. **M.D.Raisinghania**, Advanced Differential Equations , S.Chand and company Ltd.,New Delhi,2001.
2. **E.T.Copson,** Partial Differential Equations, Cambridge University Press,1975.

COURSE OUTCOMES:
After the completion of this course, the students will be able to

1. Describe the most common partial differential equations that appear in problems concerning heat conduction, flow, elasticity and wave propagation.
2. Solve the existence and uniqueness of solutions and continuous dependence of initial and boundary data.
3. Solve simple first order equations using the method of characteristics.
4. Formulate maximum principles for various equations and derive consequences.
5. Identify real phenomena as models of partial differential equations.

OUTCOMES MAPPING:

Course outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	√	√		√		√	√	√	√	√
CO2	√	√		√		√		√		√
CO3			√		√		√			
CO4			√	√			√	√		√
CO5	√					√		√		

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SEMESTER – II

ELECTIVE COURSE

FRACTIONAL CALCULUS

Subject Code:	Credits: 5	External Marks: 75	Hours: 6

OBJECTIVES:

To enable the students to

1. Provide a comprehensive idea about Fractional Calculus.
2. Evaluate fractional integrals, fractional derivatives for some functions.
3. Introduce the concept of fractional differential equations and consider some of their applications.
4. Develop skills in solving homogeneous and non homogeneous fractional differential equations.
5. Study the numerical solutions of fractional differential equations.

UNIT I: Introduction

The iterated integral approach – The differential equation approach – The complex variable approach – The Weyl transform – The fractional derivative – The definition of Grunwald and Marchaud.

UNIT II: The Riemann- Liouville Fractional Integral

Introduction – Definition of the fractional integral – Some examples of fractional integrals – Dirichlet's formula – Derivatives of the fractional integrals and the fractional integral of the derivative – Laplace transform of the fractional integral – Leibniz's formula for fractional integrals.

UNIT III: The Riemann-Liouville Fractional Integral

Introduction – The fractional derivative – A class functions – Leibniz's formula for fractional derivatives – Some further examples – The law of exponents – Integral Representations – Representations of functions – Integral relations – Laplace transform of the fractional derivative.

UNIT IV: Homogeneous Fractional Differential Equations :

Introduction – Direct approach – Laplace transform – Linearly independent solutions – solution of the homogeneous equations – Explicit representation of the solution.

UNIT V: Non – homogeneous Fractional Differential Equations:

Relation to the Green's function – Solution of the non homogeneous fractional differential equations – convolution of fractional Green's function – Reduction of fractional differential equations to ordinary differential equations – Semi differential equations.

TEXT BOOK: Kenneth S. Miller and Bertram Ross, An Introduction to the Fractional Calculus and Fractional Differential Equations, A Wiley-inter science publication, John Wiley and Sons Inc. , 1993.

REFERENCES:

(1) Igor Podlubny, Fractional Differential Equations, San Diego, Academic Press, 1999.

(2) K.B. Oldham and J. Spanier, The Fractional Calculus, Academic Press, New York, 1974

COURSE OUTCOMES:

At the end of the course , the students will be able to

1. Understand the general Theory of Fractional Calculus.
2. State sufficient conditions under which the fractional integrals and derivatives exist.

3. Investigate some applications of the fractional calculus to the real world.

1. Solve linear fractional differential equations using the Laplace transform.
2. Extend their knowledge to do research work on the methods and similar type of other methods.

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	√					√				
CO2			√				√			√
CO3				√				√		
CO4		√								√
CO5	√		√			√				√

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SEMESTER – II
ELECTIVE COURSE

EC – ADVANCED ALGEBRA

Subject Code:	Credits: 4	External Marks: 75	Hours:6

OBJECTIVES*:*
To enable the students to

1. Learn advanced algebraic structures in algebra.
2. Be familiar with density theorem and Weddurnburn theorems.
3. Acquire knowledge in algebraic structures such as Artinian rings and semisimple rings.

UNIT I: **The Jacobson Radical:** Modules – The radical of a ring.

UNIT II: Artinian Rings – Semisimple Artinian rings.

UNIT III: **Semisimple Rings:** The density theorem – Semisimple rings.

UNIT IV: **Commutative theorems:** Weddurnburn's theorem and some applications.

UNIT V: **Commutative theorems(continued):** some special rings.

TEXT BOOK: I. N. Herstein, Non Commutative Rings, Number Fifteen, The Mathematical Association of America.

UNIT I : Chapter 1: 1.1 to 1.2
UNIT II : Chapter 1: 1.3 to 1.4
UNIT III : Chapter 2: 2.1 to 2.2
UNIT IV : Chapter 3: 3.1
UNIT V : Chapter 3: 3.2

REFERENCES:

1. I. N. Herstein, Theory of rings, University of Chicagi, Math.notes, 1961.
2. Nathan Jacobson, Structures of rings,Amer.Math.Soc.Colloq.Publ., 1964.

COURSE OUTCOMES:

After the completion of this course, the students will be able to

1. Explain efficient use of advanced algebraic techniques.
2. Understand Weddurnburn's theorem and its applications.
3. Construct a general structure theory for associative rings.
4. Concentrate on the bothersome behavior of a ring.
5. Learn the applications of Artinian ring in a variety of places in algbera.

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	√	√		√	√	√	√	√	√	√
CO2		√	√			√	√		√	√
CO3	√	√	√	√			√	√	√	√
CO4		√	√			√	√	√		√
CO5	√		√			√	√		√	√

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SEMESTER - III

CC9 - TOPOLOGY

Subject Code: 20P3M11	Credits: 5	External Marks: 75	Hours: 6

OBJECTIVES:

To enable the students to

1. Provide the knowledge of topological spaces and their importance.
2. Acquaint students with the concept of homeomorphism and the topological properties.
3. Acquaint mathematical concepts which can be generalized in topological spaces, so that students may learn and appreciate the nature of abstract mathematics.
4. Introduce various spaces and subspaces in Real line and their properties.
5. Introduce connectedness and compactness in metric spaces and related theorems.

UNIT I: Topological spaces – basis for a topology – the order topology – the product topology on XxY - The subspace topology – closed sets and limits points.

UNIT II: Continuous functions - The product topology – The metric topology – The metric topology continued.

UNIT III: Connected spaces- connected subspaces of the Real line - Compact spaces –compact subspaces of the Real line.

UNIT IV : The countability axioms – The Seperation axioms- Normal spaces - The Urysohn lemma – The Urysohn metrization theorem.

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UNIT V: The Tychonoff theorem – The Stone-cech Compactificaion – Complete metric spaces – Compactness in metric spaces.

TEXT BOOK: James R. Munkres, Topology , Second Edition, Pearson Education India, 2000.

UNIT I : Chapter2: Sec 12 to 17
UNIT II : Chapter2: Sec 18 to 21
UNIT III : Chapter3: Sec 23 to 27 (except 25)
UNIT IV : Chapter4: Sec 30 to 34
UNIT V : Chapter4: Sec 37 &38 Chapter 7: Sec 43 & 45

REFERENCES:

1. G.F. Simmons, Introduction To Topology And Modern Analysis, Robert E. Krieger Publishing Company, Malabar, Florida, 1983.
2. J.G.Hocking And G.S.Young, Topology, Dover Publications,1988.

COURSE OUTCOMES:

At the end of the course, the students will be able to

1. Understand the concepts of topological spaces and the basic definitions of open sets, neighbourhood, interior, exterior, closure and their axioms for defining topological spaces.
2. Understand the concept of bases and subbases, continuity, compactness, connectness, homeomorphism and topological properties.
3. Understand how points of space are separated by open sets, Hausdorff spaces and their importance.
4. Understand regular and normal spaces and some important theorems in these spaces.
5. Understand the concepts of connected spaces, connected subspaces in real line and compactification in metric spaces and their topological properties.

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	√			√						
CO2						√	√			
CO3		√				√				
CO4										√
CO5			√		√					

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SEMESTER - III

CC 10 - DIFFERENTIAL GEOMETRY

Subject Code: 20P3M12	Credits: 5	External Marks: 75	Hours: 6

OBJECTIVES:

To enable the students to

1. Be familiar with basic concepts of differential Geometry.
2. Learn the notion of surfaces and their properties.
3. Deal with geometry of curves and space, using the methods of differential calculus.
4. Study geodesics and differential geometry of surfaces

UNIT I : **Curves in the plane and in space**: Curves, Parametrisation, arc length, Level, curves, curvature, plane and space curves.

UNIT II: **Surfaces in space:** Surface patches, smooth surfaces, tangents, Normals orientability, examples of surfaces, lengths of curves on surfaces, the first fundamental form, isometries, surface area.

UNIT III: **Curvature of surfaces:** The second fundamental form, Curvature of curves on a surface,normal, principal, Gaussian and mean curvatures, Gauss map.

UNIT IV: **Geodesics :** Geodesics, geodesic equations, geodesics as shortest paths, geodesic coordinates.

UNIT V: **TheoremaEgregium of Gauss :** TheoremaEgregium, Isometries of surfaces, Codazzi-Mainardi equations, compact surfaces of constant Gaussian curvature.

TEXT BOOK: Andrew Pressley, Elementary Differential Geometry, Second Edition, Springer Undergraduate Mathematics Series, 2010.

UNIT I **:** Chapters 1 and 2
UNIT II **:** Chapter 4 - 4.1, 4.2, 4.3, 4.4, 4.7 and Chapter 5 - 5.1, 5.2, 5.4
UNIT III **:** Chapter 6 - 6.1, 6.2, 6.3 and Chapter 7 - 7.1, 7.5,7.6
UNIT IV **:** Chapter 8 - 8.1, 8.2, 8.4, 8.5
UNIT V **:** Chapter 10

REFERENCES:

1. T.J. Willmore, An Introduction to Differential Geometry, Oxford University Press,(17thImpression) New Delhi 2002. Struik, D.T. Lectures on Classical Differential Geometry, Addison - Wesley, Mass.1950.
2. Kobayashi S. and Nomizu. K. Foundations of Differential Geometry, Interscience Publishers, 1963.
3. Wihelm Klingenberg: A course in Differential Geometry, Graduate Texts in Mathematics, Springer Verlag, 1978.
4. J.A. Thorpe Elementary topics in Differential Geometry, Under – graduate Texts in Mathematics, Springer - Verlag 1979.

COURSE OUTCOMES:

At the end of the course, the students will be able to

1. Explain the physical properties of different curves and spaces.
2. Determine curvature of curves in different co-ordinate systems.
3. Analyze curvature of surfaces in different settings.
4. Explain the geometry of different types of curves and spaces.
5. Use the theory and techniques of the course to solve mathematical problems.

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1						√				
CO2			√				√			
CO3					√					√
CO4		√					√			
CO5				√				√		

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SEMESTER - III

CC11 - PRACTICALS IN MATHEMATICA

Subject Code: 20P3M13	Credits: 4	External Marks: 75	Hours: 6

OBJECTIVES:

To enable the students to

1. Write programmes in solving mathematical problems.
2. Prepare for software developments.
3. Understand the fundamentals of procedural and functional programmings.
4. Learn how to use mathematica as a tool for modelings.
5. Improve collaboration, presentation and writing skills.

UNIT I: **Introduction to Mathematica:** Running Mathematical – Numerical Calculations – Building Up calculations – Using the Mathematics system – Algebraic calculations – Symbolic Mathematics – Numerical Mathematics.

UNITII: Functions Programs – Lists – Graphics – Inputs and Outputs in Notebooks – The structure of Graphics.

UNIT III: **Advanced Mathematics in Mathematica:** Mathematical Functions – Algebraic Manipulating Equations–Calculus.

UNIT IV: Series, Limits and Residues – Linear Algebra – Constructing matrices – Getting pieces of matrices –scalars, Vectors and Matrices – Operations on scalars, vectors and matrices – Multiplying Vectors and matrices – Matrix inversion – Basic matrix operations – Solving linear systems – Eigen values and Eigen vectors.

UNIT V: Numerical operations on data – Curve fitting – Approximate functions and Interpolation – Fourier Transforms. Numerical operations on functions – Numerical Integration – Numerical evaluation of sums and products – Numerical Solution of Polynomial equations – Numerical root finding – Numerical solutions of Differential equations.

TEXT BOOK: Stephen Wolfram, The Mathematica Book, Fifth Edition, Cambridge University Press, 2003.

COURSE OUTCOMES:

After the completion of this course, the students will be able to:

1. Learn how to use mathematica programming language at an advanced level.
2. Implement various algorithms in the mathematica language.
3. Know the mathematical software and specialized package of programs designed to solve applied mathematical problems, basic computer technologies for mathematical research and criterias for evaluating the effectiveness of using various algorithms, methods and computer technologies.
4. Know how to choose software tools and professionally use computers for solution of applied problems.
5. Have the skills of finding adequate and effective ways of solving mathematical problems with using computer technology.

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	√		√			√				
CO2				√					√	
CO3	√				√	√				
CO4			√					√		
CO5	√					√	√			√

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ELECTIVE COURSE
SEMESTER – III

EC - GRAPH THEORY

Subject Code:	Credits: 5	External Marks: 75	Hours: 6

OBJECTIVES:

To enable the students to

1. Understand the concepts of graph theory and to motivate them to do research.
2. Deal with elementary concepts such as trees, Eulerian, Hamiltonian graphs , matching, vertex and edge coloring and planar graphs.
3. Formulate real life problems into graph theoretic models.
4. Use the techniques of proofs and analysis.
5. Be familiar with the most fundamental graph theory topics and results.

UNIT I : **GRAPHS AND SUBGRAPHS**- Graphs and simple graphs – graph isomorphism – The incidence and adjacency matrices – Subgraphs – Vertex degrees – Paths and connections – Cycles.
TREES-Trees – cut edges and bonds – Cut vertices – Cayley's formula.

UNIT II : **CONNECTIVITY**-Connectivity – Blocks – Construction of reliable communication networks. **EULER TOUR AND HAMILTONIAN CYCLES** – Euler tours – Hamilton cycles – The Chinese postman problem – The traveling salesman problem.

UNIT III: **MATCHINGS**- Matchings – Matchings and Coverings in bipartite Graphs- Perfect Matchings. **EDGE COLOURINGS**– Edge chromatic number – Vizing's theorem.

UNIT IV: **INDEPENDENT SETS & CLIQUES** – Independent sets – Ramsey's theorem – Turan's theorem. **VERTEX COLOURINGS**: Chromatic number – Brook's theorem –Hajos' conjecture – Chromatic polynomials.

UNIT V: **PLANAR GRAPHS** – Plane and planar graphs – Dual graphs – Euler's Formula– Bridges- Kuratowski's Theorem – The five colour theorem.

TEXT BOOK: Graph Theory With Applications By J.A. Bondy And U.S.R. Murthy, The Macmillan Press Ltd., 1976.

UNIT I **:** Chapters 1 & 2: 1.1 – 1.7 & 2.1 – 2.4
UNIT II **:** Chapters 3 & 4 :3.1 – 3.3 & 4.1 – 4.4
UNIT III **:** Chapters 5 & 6 : 5.1 – 5.3 & 6.1, 6.2
UNIT IV **:** Chapters 7 & 8: 7.1 – 7.3 & 8.1 – 8.4
UNIT V **:** Chapter 9: 9.1- 9.6.

REFERENCES:

1. Narasingh Deo, “Graph Theory: with Application to Engineering and Computer Science, Prentice hall of India, 2003.
2. R. Balakrishnan and K. Ranganathan, “A Textbook of Graph Theory”, second edition, Springer, Newyork, 2012.

COURSE OUTCOMES:

After completion of the course, the student will be able to

1. Explain the basic concepts of different classes of graphs with examples.
2. Describe and solve some real time problems using concepts of graph theory.
3. Define how graphs serve as models for standard problems.
4. See the applications of graphs in science, business and industry.
5. Use a combination of theoretical knowledge and independent mathematical thinking in creative investigation of question in graph theory.

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	√	√			√	√	√	√		
CO2		√	√			√	√	√		
CO3	√			√			√		√	
CO4	√	√			√	√	√			
CO5	√			√			√			√

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ELECTIVE COURSE
SEMESTER – III

EC - OPTIMIZATION TECHNIQUES

Subject Code:	Credits: 5	External Marks: 75	Hours: 6

OBJECTIVES:

To enable the students to

1. Understand and apply some of the Techniques of Operations Research.
2. Study the advanced level topics in Linear Programming and Non linear programming, Integer and Dynamic programming problems.
3. Develop and promote research interest in applying optimization techniques in problems in engineering and Technology.
4. Learn basic optimization techniques in order to get best results for a set of several possible solutions of different problem viz linear programming problems Duality problem, Dual simplex method, integer programming problem and Dynamic problem and non linear programming problems.
5. Participate in various competitive examinations and applications.

UNIT I : **Duality in Linear programming:** Introduction – General Primal – Dual Pair – formulating a Dual problem – Primal – Dual pair in Matrix form – Duality Theorems – Complementary Slackness Theorem – Duality and Simplex method; Advanced Linear programming Techniques: Introduction -Revised simplex method.

UNIT II: **Integer Programming Problem :** Introduction – Gomory's All – I.P.P. method – Construction of Gomory's constraints- Fractional cut method- All integer - Fractional cut method- mixed integer – Branch and Bound method

UNIT III: **Dynamic Programming:** Introduction–The Recursive Equation Approach –Characteristics of Dynamic programming – Dynamic programming Algorithm – Solution of Discrete D.P.P – Some Applications - Solution to L.P.P by Dynamic Programming.

UNIT IV: **Simulation**: Introduction - why simulation? –methodology of simulation – Simulation models – Event Type simulation - Generation of Random numbers – Monte Carlo simulation.

UNIT V: **Non- Linear Programming:** Introduction Formulating a non-linear programming problem - General Non-linear Programming problem – Constrained optimization with equality constraints - Constrained optimization with inequality constraints. Graphical solution – Kuhn – Tucker conditions with non-negative constraints.

TEXT BOOK: P.K.Gupta and Manmohan, Operations Research, Eleventh Edition Kanthi Swarup, 2003.

UNIT – 1 : Chapter 5: Sec 5.1 to 5.7,Chapter 9: Sec 9.1,9.2
UNIT – 2 : Chapter 7: Sec 7.1 to 7.6
UNIT – 3 : Chapter 13: Sec 13.1 to 13.7
UNIT – 4 : Chapter 23 : Sec 23.1 to 23.7
UNIT – 5 : Chapter 24:Sec 24.1 to 24.5 & Chapter 25: Sec 25.2, 25.3

REFERENCES:

1. Hamdy A. Taha, Operations research(7th Edition), Mc Graw Hill Publications, New delhi,2002.
2. O. L. Mangasarian, Non linear programming, Mc Graw Hill, Newyork, 1979.
3. Premkumar Gupta and D.S. Hira, Operations Research: An introduction, S.Chand, Delhi ,1979.

COURSE OUTCOMES:

After completion of the course, the student will be able to

1. Understand the theory of optimization methods and algorithms developed for solving various types of optimization problems.
2. Extend their knowledge of basic optimization techniques to do interesting research work on these types of optimization techniques.
3. Identify and know about simulation in operations research.
4. Highlight some of the applications of optimization techniques.
5. Apply into real life problems.

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	√					√		√		
CO2		√		√		√				√
CO3			√						√	
CO4				√						
CO5					√		√			

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SEMESTER – III
ELECTIVE COURSE

EC -MATHEMATICAL MODELS IN BIOLOGY AND MEDICINE

Subject Code:	Credits: 5	External Marks: 75	Hours: 6

OBJECTIVES:

To enable the students to

1. Understand the basic concept of biology related to mathematical models.
2. Apply the concept of mathematics and statistics in biology and medicine.
3. Find solutions for socio economic issues.
4. Know the applications in real time situations.

UNIT I: **Microbial population models:** Importance of microbial kinetics – microbial growth in a chemostat – stability of steady state for chemostat – growth of microbial population.

UNIT II: **Models in genetics:** Basic models for inheritance - further discussion of basic model for inheritance of genetic characteristics – models for genetic improvement : selection and mutation.

UNIT III: **Mathematical models in pharmacokinetics:** Basic equations and their real solutions – solutions for special cases – determination of transfer coefficient and compartment volumes.

UNIT IV: Mathematical techniques used in compartment analysis – stochastic compartment models.

UNIT V: **Optimization models in biology and medicine:** Some simple optimization models – optimization models for blood testing and patient care – models for optimal control of water pollution.

TEXT BOOK: J.N. Kapur, " Mathematical models in Biology and medicine", Affiliated east-west press PVT Ltd. New delhi 1985

Chapter 2 – Sections 2.1 to 2.4
Chapter 9 – Sections 9.1 to 9.3
Chapter 10 – Sections 10.1 to 10.3
Chapter 10 – Sections 10.4 to 10.5
Chapter 14 – Sections 14.1 to 14.3

REFERENCES: J.N. Kapur, Mathematical Modeling, New age international private limited, 2015.

COURSE OUTCOMES:

After the completion of this course, the students will be able to

1. Understand the microbial kinetics and microbial growth
2. Analyze the genetic issues in society
3. Know the effect of continuous intake of medicines in Human system
4. Understand causes and effects of diseases and their medication
5. Apply the knowledge of optimization to reduce the cost of blood testing and pollution control problems.

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	√	√	√	√		√		√		√
CO2		√		√				√		√
CO3		√	√	√				√		
CO4			√					√		
CO5			√	√				√		

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SEMESTER - IV

CC 12 - FUNCTIONAL ANALYSIS

Subject Code: 20P4M16	Credits: 5	External Marks: 75	Hours: 6

OBJECTIVES:

To enable the students to

1. Understand the basic concepts and theorems in functional analysis.
2. Extend the concepts of Real Analysis and linear Algebra.
3. Understand continuous linear transformations and the Hahn-Banach theorem.
4. Comprehend the open mapping theorem and closed graph theorem.
5. Acquire different linear spaces and its applications.
6. Obtain knowledge on operator theory and finite dimensional spectral theory.

UNIT I: **BANACH SPACES**: Definitions and some examples – Continuous Linear transformations – The Hahn Banach Theorem –The natural imbedding of N in N** -The open mapping Theorem – The conjugate of an operator.

UNIT II: **HILBERT SPACES**: Definitions and simple properties – Orthogonal Complements - Orthonormal sets – The conjugate space H*.

UNIT III: **OPERATORS ON BANACH AND HILBERT SPACES.** The adjoint of an operator – Self adjoint operators – Normal and unitary operators.

UNIT IV: **Projections . Finite dimensional spectral theory:** Matrices – Determinants and the spectrum of an operator -the Spectral Theorem.

UNIT V: **GENERAL PRELIMINARIES ON BANACH ALGEBRAS**: Definitions and some examples – Regular and Singular Elements – Topological Divisors of Zero – The spectrum – The Formula for the spectral Radius.

TEXT BOOK:

G.F. Simmons , Introduction To Topology And Modern Analysis, Mc Graw Hill, New York ,1963.

UNIT I : Chapter 9 : 46 - 51
UNIT II : Chapter 10 : 52 - 55
UNIT III : Chapter 10 : 56 - 58
UNIT IV : Chapter 10 : 59, Chapter11 : 60 - 62
UNIT V : Chapter 12 : 64 – 68

REFERENCES:

1. B.V.Limaye, Functional Analysis, New Age International,1996.
2. G.Bachman and L.Narici, Functional Analysis, Dover Publications,2000.

COURSE OUTCOMES :

After the completion of this course, the students will be able to

1. Understand functional analytic language required to study problem of practical interest.
2. Apply the theory of functional analysis in the qualitative study of different mathematics models in biological and Ecological systems and different engineering problems.
3. Understand the relevance of self adjoint operators, normal, unitary operators and projections.
4. Explain the concepts of projections on Hilbert and Banach spaces.
5. Comprehend the ideas of determinants and spectrum of operators.

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	√			√		√				
CO2				√			√			
CO3			√					√		
CO4		√							√	
CO5					√					√

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SEMESTER - IV

CC 13 - MEASURE THEORY AND INTEGRATION

Subject Code: 20P4M17	Credits: 5	External Marks: 75	Hours: 6

OBJECTIVES:

To enable the students to

1. Recall the concepts of probability theory and consider them from a measure theoretic point of view.
2. Learn the basic elements of measure theory with related discussions on applications in probability theory.
3. Generalize the concept of integrations using measures.
4. Acquire a concrete setting of Lebesgue measure and Lebesgue integral via the classical concepts of Jordan measure and the Riemann integrals.
5. Have a foundation for many branches of mathematics such as harmonic analysis, ergodic theory, theory of partial differential equations and probability theory.

UNIT I: **Measure on the real line:** Lebesgue outer measure - Measurable sets –Regularity – Measurable functions – Borel and Lebesgue Measurability.

UNIT II: **Integration of functions of a real variable:** Integration of non negative functions – The general integral – Integration of series – Riemann and Lebesgue integrals.

UNIT III: **Abstract measure space:** Measures and outer measures – Completion of a measure - Measure spaces - Integration with respect to a measure.

UNIT IV: **Convergence :**Convergence in measure – Almost uniform convergence – Signed measures and the Hahn decomposition.

UNIT V: The Jordan decomposition – The Radon-Nikodym theorem – Measurability in a product space.

TEXT BOOK: G. de Barra, Measure Theory and Integration, New Age International Publishers, New Delhi, 2011.

UNIT I **:** Chapter 2: Sections 2.1 to 2.5
UNIT II : Chapter 3: Sections 3.1 to 3.4
UNIT III : Chapter 5: Sections 5.1 , 5.4, 5.5, 5.6
UNIT IV : Chapter 7: Sections 7.1, 7.2 and Chapter 8: Sections 8.1
UNIT V : Chapter 8: Sections 8.2, 8.3 and Chapter 10:Section 10.1

REFERENCES:

1. Real Analysis, H.L. Royden, Third Edition, PrenticeHall of India, New Delhi, 2001
2. Real and Complex Analysis, Walter Rudin, Mc-Graw Hill Book Company, New York, 1970.

COURSE OUTCOMES:

After the completion of this course, the students will be able to

1. Understand the fundamentals of measure theory and be acquainted with the proofs of the fundamental theorems underlying the theory of integration.
2. Develope probabilistic concepts, such as random variables, expectations and limits, within the framework of measure theory.
3. Develope a perspective on the broder impact of measure theory in ergodic theory and have the ability to pursue further studies in this and related area.
4. Apply the general principles of measure theory and integration in financial mathematics.
5. Apply the main inequalities of measure theory in a wide range of contexts.

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	√					√	√			√
CO2				√			√	√		
CO3	√	√		√	√	√			√	
CO4				√						√
CO5			√	√				√		

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SEMESTER - IV

CC 14 - NUMBER THEORY

Subject Code: 20P4M18	Credits: 4	External Marks: 75	Hours: 6

OBJECTIVES:

To enable the students to

1. Solve polynomial congruences by help of the Chinese remainder theorem.
2. Identify and analyze different types of divisibility tests, Euler's theorem, Wilson theorem, Mobius inversion formula to formulate and solve various related problems.
3. Decide whether a given number is the sum of two or three squares, a given number is a quadradic residue modulo p.
4. Develop right approach towards research in number theory.

UNIT I: Fundamentals of congruences : Basic properties of congruences – Residue Systems - Riffling. Solving congruences: Linear congruences – The theorems of Fermat and Wilson revisited – The Chinese Remainder theorem – Polynomial Congruences.

UNIT II: Arithmetic functions: Combinatorial study of $\phi(n)$ – Formulae for D(n) and $\sigma(n)$ - Multiplicative Arithmetic functions – The Mobius Inversion formula.Primitive roots: Properties of reduced Residue systems – Primitive roots Modulo P.

UNIT III: Quadratic Residues: Euler's criterion – The Legendre symbol – The Quadratic reciprocity law – Applications of Quadratic Reciprocity law. Distributions of Quadratic Residues: Consecutive Residues and non residues.

UNIT IV: Sums of squares :Sums of two squares – Sums of Four Squares. Elementary partition theory: Introduction - Graphical representation – Euler's partition theorem – Searching for partition Identities.

UNIT V: Partition generating Functions: Infinite Products as Generating functions – Identities between Infinite series and Products. Partition Identities: History and Introduction – Euler's Pentagonal Number Theorem – The Roger's Ramanujan Identities.

TEXT BOOK: E. Andrews, Number Theory, Published by Courier Corporation ,1971.

UNIT I : Chapters 4 & 5.
UNIT II : Chapters 6 & 7.
UNIT III : Chapters 9 & 10 (omit 10.2)
UNIT IV : Chapters 11 & 12.
UNIT V : Chapters 13 & 14(omit 14.4 & 14.5).

REFERENCES:

1. J.William, Fundamentals of number theory, Leveque, Addison Wesley Publishing company,Philipines,1977.
2. Tom.M.Apostol, Introduction to analytics number theory, Springer Science and business Media,1998.

COURSE OUTCOMES:

At the end of the course, students will be able to

1. Write programs/functions to compute number theoretic functions.
2. Use mathematical induction and other types of proof writing techniques.
3. Understand and utilize mathematical functions, empirical priniciples and processes.
4. Apply the knowledge of number theory to attain a good mathematical maturity and enable to build mathematical thinking skill.
5. Use continued fractions to develop abitarily accurate rational approximations to rational and irrational numbers.

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1			√					√	√	
CO2	√		√		√			√		√
CO3	√			√			√		√	
CO4	√		√		√	√			√	
CO5		√				√				√

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SEMESTER - IV

EC - PROBABILITY AND STATISTICS

Subject Code:	Credits: 4	External Marks: 75	Hours: 6

OBJECTIVES:

To enable the students to

1. Provide mathematical foundation for statistics.
2. Learn probability and various types of distribution.
3 Compute expectations and moments on a number of distribution.
4. Solve widely varied problems.

UNIT I: **Probability and Distribution**: The probability set function – Conditional probability and independence – Random variables of the discrete type – Random variables of the continuous type – properties of the distribution function – expectation of random variable – some special expectations.

UNIT II: **Multivariate Distributions:** Distributions of two random variables – conditional distributions and expectations – the correlation coefficient – Independent random variables – extension to several random variables.

UNIT III: **Some special Distributions:** The Binomial and related distributions – The Poisson distribution– The Gamma and Chi-square distributions – The Normal distributions – The Bivariate Normal distribution.

UNIT IV: **Distributions of functions of Random variables:** Sampling theory – Transformations of variables of the discrete type – transformations of variables of the continuous type – the Beta, t and F distributions – the moment generating – function techniques - the distributions of $\bar{X}$ and ns^2/σ^2.

UNIT V: **Limiting Distributions:** Convergence in distribution – convergence in probability – Limiting Moment Generating functions – the Central Limit theorem – Some theorems on Limiting Distributions.

TEXT BOOK: Robert V.Hogg and AllenT. Craig, Introduction to Mathematical Statistics, Fifth edition, Pearson Education Asia 2002.

UNIT I **:** Chapter 1: Sections 1.3 to 1.9
UNIT II : Chapter 2: Sections 2.1 to 2.5
UNIT III : Chapter 3: Sections 3.1 to 3.5
UNIT IV : Chapter 4: Sections 4.1 to 4.4 & 4.7,4.8
UNIT V : Chapter 5: Sections 5.1 to 5.5

REFERENCES:

3. K.L.Chang ,A Course in Probability, Academic Press, New York,1974.
4. M.Fisz, Probability theory and Mathematical Statistics, John- Wiley and Sons, New York,1963.
5. J.E.Freund, Mathematical Statistics,Prentice Hall of India,2001.

COURSE OUTCOMES:

After the completion of this course, the students will be able to

1. Acquire knowledge related to probability problem.
2. Gain a basic knowledge for studying advanced course in this area like stochastic processes.
3. Apply the fundamental concept of statistical methods to solve some real life problems.
4. To learn the concepts of the different types of discrete and continuous distributions and their utilization.
5. Compute expectations and moments on a number of distributions.

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	√		√	√		√	√	√		
CO2		√		√		√		√		√
CO3			√			√				
CO4	√			√			√		√	√
CO5					√					

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ELECTIVE COURSE
SEMESTER – IV

EC -COMBINATORICS

Subject Code:	Credits: 5	External Marks: 75	Hours: 6

OBJECTIVES:

To enable the students to

1. Expose the Techniques and analysis
2. Be familiar with the most fundamental combinatorics topics and results.

UNIT I: **Permutations and combinations:** Rules of sum and product – permutations of non-distinct objects – combinations with repetitions – distributions of distinct and non- distrinct objects.

UNIT II: **Generating Functions:** Ordinary generating functions – generating functions for combinations when repetitions are allowed in the selection – enumerators for permutations – exponential generating functions.

UNIT III: Exponential enumerators – partitions of integers – elementary relations on the operations of generating functions.

UNIT IV: **Recurrence Relations:**Linear recurrence relations with constant coefficients – Characteristic equations and characteristic roots – Tower of Hanoi problem – Solution by the Technique of generating functions.

UNIT V: **Principle of inclusion and exclusion:** Counting theorem – applications – more general formula for the number of objects that have exactly m of the r properties – derangements – permutations with restrictions on relative position – rook polynomials.

TEXT BOOK: C.L. Liu, " Introduction to Combinatorial Mathematics" First Edition, Mcgraw Hill Book company, New York 1968

Chapter 1 – Sections 1.1 to 1.6
Chapter 2 – Sections 2.1 to 2.4
Chapter 3 – Sections 2.5 to 2.7
Chapter 4 – Sections 3.1 to 3.3
Chapter 5 – Sections 4,1 to 4.6

REFERENCES:

1. S.S. Sane, Combinatorial Techniques, First Edition, Hindustan Book Agency, New Delhi, 2013.
2. A. Tucker, Applied combinatorics, Fourth Edition, John Wiley & Sons, New York, 2003.
3. C. Vasudev, Theory and problems of combinatorics First Edition, New Age International Publishers New Delhi 2005.

COURSE OUTCOMES:

After the completion of this course, the students will be able to

1. Carry over knowledge from combinatorics.
2. Present clear and detailed solutions to assigned problems.
3. Read and understand assigned sections of the first books.
4. Study a new combinatorial topic and present this topic to their peers.
5. Use mathematical definitions to identity and construct examples and to distinguish examples from non- examples.
6. Construct mathematical proofs.

OUTCOMES MAPPING:

Course Outcomes	Programme Outcomes					Programme Specific Outcomes				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	√					√				
CO2			√				√			√
CO3				√				√		
CO4		√								√
CO5	√		√			√				√

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SEMESTER - IV
PW - PROJECT WORK

Subject Code: 20P4MPW	Credits: 4	External Marks: 80	Hours:6