Thiruvalluvar University

Syllabus for I semester

Credit Distribution for PG Programme in Mathematics

M.Sc., Mathematics

	First Year Semester-I	**Credit**	**Hours per week(L/T/P)**
Part A	CC1 - Algebraic Structures	5	7
	CC2 - Real Analysis I	5	7
	CC3 - Ordinary Differential Equations	4	6
	Elective I(Generic / Discipline Specific)(One from Group A)	3	5(4L + 1T)
	Elective II(Generic / Discipline Specific)(One from Group B)	3	5(4L + 1T)
	Total	**20**	**30**

Elective I to be chosen from Group A and **Elective II** to be chosen from Group B

Group A: (PM/AP/IC/ITC)

1. Number Theory and Cryptography
2. Graph Theory and Applications
3. Formal Languages and Automata Theory
4. Programming in C++ and Numerical Methods

Group B:(PM/AP/IC/ITC)

1. Lie Groups and Lie Algebras
2. Mathematical Programming
3. Fuzzy Sets and Their Applications
4. Discrete Mathematics

Title of the Course		**ALGEBRAIC STRUCTURES**						
Paper Number		**CORE I**						
Category	Core		I	**Credits**	4	**Course Code**		
		Semester	I					
Instructional Hours per week		**Lecture**		**Tutorial**		**Lab Practice**	**Total**	
		4		1		--	5	
Pre-requisite		UG level Modern Algebra						
Objectives of the Course		To introduce the concepts and to develop working knowledge on class equation, solvability of groups, finite abelian groups, linear transformations, real quadratic forms						

Course Outline	**UNIT-I :** Counting Principle - Class equation for finite groups and its applications - Sylow's theorems (For theorem 2.12.1, First proof only). **Chapter 2: Sections 2.11 and 2.12 (Omit Lemma 2.12.5)**
	UNIT-II : Solvable groups - Direct products - Finite abelian groups- Modules **Chapter 5 : Section 5.7 (Lemma 5.7.1, Lemma 5.7.2, Theorem 5.7.1)** **Chapter 2: Section 2.13 and 2.14 (Theorem 2.14.1 only)** **Chapter 4: Section 4.5**
	UNIT-III : Linear Transformations: Canonical forms –Triangular form - Nilpotent transformations. **Chapter 6: Sections 6.4, 6.5**
	UNIT-IV : Jordan form - rational canonical form. **Chapter 6 : Sections 6.6 and 6.7**
	UNIT-V: Trace and transpose - Hermitian, unitary, normal transformations, real quadratic form. **Chapter 6 : Sections 6.8, 6.10 and 6.11 (Omit 6.9)**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	I.N. Herstein. *Topics in Algebra* (II Edition) Wiley Eastern Limited, New Delhi, 1975.
Reference Books	1. M.Artin, *Algebra,* Prentice Hall of India, 1991. 2. P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, *Basic Abstract Algebra* (II Edition) Cambridge University Press, 1997. (Indian Edition) 3. I.S.Luther and I.B.S.Passi, *Algebra,* Vol. I –Groups(1996); Vol. II Rings, Narosa Publishing House , New Delhi, 1999 4. D.S.Malik, J.N. Mordeson and M.K.Sen, *Fundamental of Abstract Algebra*, McGraw Hill (International Edition), New York. 1997. 5. N.Jacobson, *Basic Algebra,* Vol. I & II W.H.Freeman (1980); also published by Hindustan Publishing Company, New Delhi.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.algebra.com

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Recall basic counting principle, define class equations to solve problems, explain Sylow's theorems and apply the theorem to find number of Sylow subgroups

CLO 2: Define Solvable groups, define direct products, examine the properties of finite abelian groups,

define modules

CLO 3: Define similar Transformations, define invariant subspace, explore the properties of triangular matrix, to find the index of nilpotence to decompose a space into invariant subspaces, to find invariants of linear transformation, to explore the properties of nilpotent transformation relating nilpotence with invariants.

CLO 4: Define Jordan, canonical form, Jordan blocks, define rational canonical form, define companion matrix of polynomial, find the elementary devices of transformation, apply the concepts to find characteristic polynomial of linear transformation.

CLO 5: Define trace, define transpose of a matrix, explain the properties of trace and transpose, to find trace, to find transpose of matrix, to prove Jacobson lemma using the triangular form, define symmetric matrix, skew symmetric matrix, adjoint, to define Hermitian, unitary, normal transformations and to verify whether the transformation in Hermitian, unitary and normal

	POs						PSOs		
	1	2	3	4	5	6	1	2	3
CLO1	3	1	3	2	3	3	3	2	1
CLO2	2	1	3	1	3	3	3	2	1
CLO3	3	2	3	1	3	3	3	2	1
CLO4	1	2	3	2	3	3	3	2	1
CLO5	3	1	2	3	3	3	3	2	1

Strong: Medium: Low:

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">REAL ANALYSIS I</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">CORE II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td>Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td>4</td><td>1</td><td>--</td><td colspan="3">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">UG level real analysis concepts</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To work comfortably with functions of bounded variation, Riemann-Stieltjes Integration, convergence of infinite series, infinite product and uniform convergence and its interplay between various limiting operations.</td></tr>
<tr><td colspan="2" rowspan="4">Course Outline</td><td colspan="6">UNIT-I : Functions of bounded variation - Introduction - Properties of monotonic functions - Functions of bounded variation - Total variation - Additive property of total variation - Total variation on [a, x] as a function of x - Functions of bounded variation expressed as the difference of two increasing functions - Continuous functions of bounded variation.
Chapter – 6 : Sections 6.1 to 6.8
Infinite Series : Absolute and conditional convergence - Dirichlet's test and Abel's test - Rearrangement of series - Riemann's theorem on conditionally convergent series.
Chapter 8 : Sections 8.8, 8.15, 8.17, 8.18</td></tr>
<tr><td colspan="6">UNIT-II : The Riemann - Stieltjes Integral - Introduction - Notation - The definition of the Riemann - Stieltjes integral - Linear Properties - Integration by parts- Change of variable in a Riemann - Stieltjes integral - Reduction to a Riemann Integral – Euler’s summation formula - Monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper, lower integrals - Riemann's condition - Comparison theorems.
Chapter - 7 : Sections 7.1 to 7.14</td></tr>
<tr><td colspan="6">UNIT-III : The Riemann-Stieltjes Integral - Integrators of bounded variation-Sufficient conditions for the existence of Riemann-Stieltjes integrals-Necessary conditions for the existence of RS integrals- Mean value theorems -integrals as a function of the interval – Second fundamental theorem of integral calculus-Change of variable -Second Mean Value Theorem for Riemann integral- Riemann-Stieltjes integrals depending on a parameter- Differentiation under integral sign-Lebesgue criteriaon for existence of Riemann integrals. Chapter - 7 : 7.15 to 7.26</td></tr>
<tr><td colspan="6">UNIT-IV : Infinite Series and infinite Products - Double sequences - Double series - Rearrangement theorem for double series - A sufficient condition for equality of iterated series - Multiplication of series – Cesaro summability - Infinite products.
Chapter - 8 Sec, 8.20, 8.21 to 8.26
Power series - Multiplication of power series - The Taylor's series generated by a function - Bernstein's theorem - Abel's limit theorem - Tauber's theorem
Chapter 9 : Sections 9.14 9.15, 9.19, 9.20, 9.22, 9.23</td></tr>
</table>

	UNIT-V: Sequences of Functions – Pointwise convergence of sequences of functions - Examples of sequences of real - valued functions - Uniform convergence and continuity - Cauchy condition for uniform convergence - Uniform convergence of infinite series of functions - Riemann - Stieltjes integration – Non-uniform Convergence and Term-by-term Integration - Uniform convergence and differentiation - Sufficient condition for uniform convergence of a series - Mean convergence. **Chapter -9 Sec 9.1 to 9.6, 9.8,9.9,9.10,9.11, 9.13**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	Tom M.Apostol : *Mathematical Analysis*, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974.
Reference Books	1. Bartle, R.G. *Real Analysis*, John Wiley and Sons Inc., 1976. 2. Rudin,W. *Principles of Mathematical Analysis*, 3rd Edition. McGraw Hill Company, New York, 1976. 3. Malik,S.C. and Savita Arora. *Mathematical Anslysis*, Wiley Eastern Limited.New Delhi, 1991. 4. Sanjay Arora and Bansi Lal, *Introduction to Real Analysis*, Satya Prakashan, New Delhi, 1991. 5. Gelbaum, B.R. and J. Olmsted, *Counter Examples in Analysis*, Holden day, San Francisco, 1964. 6. A.L.Gupta and N.R.Gupta, *Principles of Real Analysis*, Pearson Education, (Indian print) 2003.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Analyze and evaluate functions of bounded variation and Rectifiable Curves.

CLO2: Describe the concept of Riemann-Stieltjes integral and its properties.

CLO3: Demonstrate the concept of step function, upper function, Lebesgue function and their integrals.

CLO4: Construct various mathematical proofs using the properties of Lebesgue integrals and establish the Levi monotone convergence theorem.

CLO5: Formulate the concept and properties of inner products, norms and measurable functions.

	POs	PSOs

	1	2	3	4	5	6	1	2	3
CLO1	3	1	3	2	3	3	3	2	1
CLO2	2	1	3	1	3	3	3	2	1
CLO3	3	2	3	1	3	3	3	2	1
CLO4	1	2	3	2	3	3	3	2	1
CLO5	3	1	2	3	3	3	3	2	1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">ORDINARY DIFFERENTIAL EQUATIONS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">CORE III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">--</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">UG level Calculus and Differential Equations</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">To develop strong background on finding solutions to linear differential equations with constant and variable coefficients and also with singular points, to study existence and uniqueness of the solutions of first order differential equations</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="7">UNIT-I : Linear equations with constant coefficients
Second order homogeneous equations-Initial value problems-Linear dependence and independence-Wronskian and a formula for Wronskian-Non-homogeneous equation of order two.
Chapter 2: Sections 1 to 6</td></tr>
<tr><td colspan="2"></td><td colspan="7">UNIT-II : Linear equations with constant coefficients
Homogeneous and non-homogeneous equation of order n –Initial value problems- Annihilator method to solve non-homogeneous equation- Algebra of constant coefficient operators.
Chapter 2 : Sections 7 to 12.</td></tr>
<tr><td colspan="2"></td><td colspan="7">UNIT-III : Linear equation with variable coefficients
Initial value problems -Existence and uniqueness theorems – Solutions to solve a non-homogeneous equation – Wronskian and linear dependence – reduction of the order of a homogeneous equation – homogeneous equation with analytic coefficients-The Legendre equation.
Chapter : 3 Sections 1 to 8 (Omit section 9)</td></tr>
<tr><td colspan="2"></td><td colspan="7">UNIT-IV :Linear equation with regular singular points
Euler equation – Second order equations with regular singular points – Exceptional cases – Bessel Function.
Chapter 4 : Sections 1 to 4 and 6 to 8 (Omit sections 5 and 9)</td></tr>
<tr><td colspan="2"></td><td colspan="7">UNIT-V : Existence and uniqueness of solutions to first order equations: Equation with variable separated – Exact equation – method of successive approximations – the Lipschitz condition – convergence of the successive approximations and the existence theorem.
Chapter 5 : Sections 1 to 6 (Omit Sections 7 to 9)</td></tr>
<tr><td colspan="2">Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)</td><td colspan="7">Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved
(To be discussed during the Tutorial hour)</td></tr>
<tr><td colspan="2">Skills acquired from this course</td><td colspan="7">Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="7">E.A.Coddington, A introduction to ordinary differential equations (3rd Printing) Prentice-Hall of India Ltd., New Delhi, 1987.</td></tr>
</table>

Reference Books	1. Williams E. Boyce and Richard C. DI Prima, *Elementary differential equations and boundary value problems*, John Wiley and sons, New York, 1967. 2. George F Simmons, *Differential equations with applications and historical notes,* Tata McGraw Hill, New Delhi, 1974. 3. N.N. Lebedev, *Special functions and their applications*, Prentice Hall of India, New Delhi, 1965. 4. W.T. Reid. *Ordinary Differential Equations*, John Wiley and Sons, New York, 1971 5. M.D.Raisinghania, *Advanced Differential Equations*, S.Chand & Company Ltd. New Delhi 2001 6. B.Rai, D.P.Choudary and H.I. Freedman, *A Course in Ordinary Differential Equations,* Narosa Publishing House, New Delhi, 2002.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Establish the qualitative behavior of solutions of systems of differential equations .

CLO2: Recognize the physical phenomena modeled by differential equations and dynamical systems.

CLO3: Analyze solutions using appropriate methods and give examples.

CLO4: Formulate Green's function for boundary value problems.

CLO5: Understand and use various theoretical ideas and results that underlie the mathematics in this course.

	POs						PSOs		
	1	2	3	4	5	6	1	2	3
CLO1	3	1	3	2	3	3	3	2	1
CLO2	2	1	3	1	3	3	3	2	1
CLO3	3	2	3	1	3	3	3	2	1
CLO4	1	2	3	2	3	3	3	2	1
CLO5	3	1	2	3	3	3	3	2	1

ELECTIVE COURSES

Courses are grouped (Group A to Group F) so as to include topics from Pure

Mathematics(PM), Applied Mathematics(AM), Industrial Components(IC) and IT Oriented(ITC) courses for flexibility of choice by the stakeholders / institutions.

Semester I : Elective I and Elective II

Elective I to be chosen from Group A and **Elective II** to be chosen from Group B

Group A: **(PM/AP/IC/ITC)**

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">NUMBER THEORY AND CRYPTOGRAPHY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">ELECTIVE</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td>Credits</td><td>3</td><td>Cours eCode</td><td></td></tr>
<tr><td>Semester</td><td>I</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2"></td><td>3</td><td colspan="2">1</td><td colspan="2">--</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">UG level Number Theory</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">1. Demonstrate ability to learn elementary ideas from number theory which will haveapplications in cryptography.
2. Introduce various cryptosystems and apply them in the necessary fields.
3. Understand the concepts of public key and primality
4. Learn the public key cryptography and RSA algorithm
5. Get the knowledge about Factoring concepts.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">UNIT–1 Some Topics in Elementary Number Theory
Time Estimates for doing arithmetic – Divisibility and Euclidean Algorithm – Congruence's– Someapplications to Factoring.
Chapter I</td></tr>
<tr><td colspan="6">UNIT–II Cryptography
Some simple cryptosystems – Enciphering matrices.
Chapter III</td></tr>
<tr><td colspan="6">UNIT–III Quadratic Residues
Quadratics – Residues and reciprocity.
Chapter II</td></tr>
<tr><td colspan="6">UNIT–IV Public Key
The idea of Public key Cryptography – RSA – Discrete Law– Knapsack –Zero–Knowledge.
Chapter IV: Sections 1 to 5</td></tr>
<tr><td colspan="6">UNIT–V Primality and Factoring
Pseudo–primes – The rho method – Fermat factorization and factor bases – The continued fractionmethod – The quadratic sieve method.</td></tr>
</table>

	Chapter V: Sections 1 to 5
Extended Professional Component	Questions related to the above topics, from various competitive examinationsUPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency,Professional Communication and Transferrable Skill

Recommended Text	1. Neal Koblitz, A Course in Number Theory and Cryptography, Springer-Verlag, New York,1987
Reference Books	1. Niven and Zuckerman, An Introduction to Theory of Numbers, Third Edition, Wiley EasternLtd, New Delhi,1976. 2. David M. Burton,Elementary Number Theory, Wm. C. Brown Publishers, Dubuque, Iowa,1989. 3. K. Ireland and M. Rosen, A Classical Introduction to Modern Number Theory, Springer–Verlag,1972.
Website and e-Learning Source	1. http://mathworld.wolfram.com 2. https://ocw.mit.edu/courses/6-042j-mathematics-for-computer-science-fall-2010/resources/lecture-4-number-theory-i/

Course Learning Outcome

After successful completion on the course the student will be able to

CO1 Acquire the knowledge of elementary number theory

CO2 Apply various cryptosystems and understand the concepts of quadratic, residues and reciprocity

CO3 Develop the idea of public key cryptography, RSA Algorithms.

CO4 Solve problems using the continued fraction method and the quadratic sieve method.

CO5 Demonstrate ability to apply concepts of Fermat factorization and factor bases.

Title of the Course		**GRAPH THEORY AND APPLICATIONS**					
Paper Number		**ELECTIVE**					
Category	Elective	**Year**	I	**Credits**	3	**Course**	

	Semester	I	**Code**	
Instructional Hours	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
per week	3	1	--	4
Pre-requisite	UG level Graph Theory			
Objectives of the Course	To study and develop the concepts of graphs, sub graphs, trees, connectivity,Euler tours, Hamilton cycles, matching, coloring of graphs, independent sets, cliques, vertex coloring, and planar graphs			
Course Outline	**UNIT-I : GRAPHS, SUBGRAPHS AND TREES** Graphs and simple graphs - Graph Isomorphism - The Incidence and Adjacency Matrices- Subgraphs - Vertex Degrees - Paths and Connection - Cycles - Trees - Cut Edges and Bonds - Cut Vertices. Chapter 1 (Section 1.1 - 1.7) ; Chapter 2 (Section 2.1 - 2.3)			
	UNIT-II : **CONNECTIVITY, EULER TOURS AND HAMILTON CYCLES** Connectivity - Blocks - Euler tours – Hamilton Chapter 3 (Section 3.1 -3.2) ; Chapter 4(Section 4.1 - 4.2)			
	UNIT-III **:MATCHINGS,** **EDGE OLOURINGS** Matchings - Matchings and Coverings in Bipartite Graphs - Edge Chromatic Number - Vizing's Theorem. Chapter 5 (Section 5.1 - 5.2) ; Chapter 6 (Section 6.1 - 6.2)			
	UNIT-IV : INDEPENDENT SETS AND CLIQUES, VERTEX COLOURINGS Independent sets - Ramsey's Theorem - Chromatic Number - Brooks' Theorem - Chromatic Polynomials. Chapter 7 (Section 7.1 – 7.2); Chapter 8 (Section 8.1 – 8.2, 8.4)			
	UNIT-V: PLANAR GRAPHS Plane and planar Graphs - Dual graphs - Euler's Formula - The Five-Colour Theorem and the Four-Colour Conjecture. Chapter 9 (Section 9.1 - 9.3, 9.6)			

Extended Professional Component	Questions related to the above topics, from various competitive examinationsUPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)

Skills acquired fromthis course	Knowledge, Problem Solving, Analytical ability, Professional Competency,Professional Communication and Transferrable Skill
Recommended Text	J.A.Bondy and U.S.R. Murthy, *Graph Theory and Applications*, Macmillan, London,1976.
Reference Books	1. J.Clark and D.A.Holton , *A First look at Graph Theory,* Allied Publishers, New Delhi,1995. 2. R. Gould. *Graph Theory*, Benjamin/Cummings, Menlo Park, 1989. 3. A.Gibbons, *Algorithmic Graph Theory*, Cambridge University Press, Cambridge,1989. 4. R.J.Wilson and J.J.Watkins, *Graphs : An Introductory Approach*, John Wiley and Sons, New York, 1989. 5. R.J. Wilson, *Introduction to Graph Theory*, Pearson Education, 4th Edition, 2004,Indian Print. 6. S.A.Choudum, *A First Course in Graph Theory*, MacMillan India Ltd. 1987.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

Title of the Course		**FORMAL LANGUAGES AND AUTOMATA THEORY**					
Paper Number		**ELECTIVE**					
Category	Elective	**Year**	I	**Credits**	3	**Course Code**	
		Semester	I				
Instructional Hours per week		**Lecture**		**Tutorial**		**Lab Practice**	**Total**
		3		1		--	4

Objectives of the Course	The purpose of this course is to acquaint the student with an overview of the theoretical foundations of computer science from the perspective of formal languages. • Classify machines by their power to recognize languages. • Employ finite state machines to solve problems in computing. • Explain deterministic and non-deterministic machines.
Course Outline	UNIT I : Finite Automata and Regular Expressions : Finite state systems- Deterministic Finite state Automata- Non deterministic Finite Automata- Finite Automata with Epsilon-Transitions – Regular Expressions- Finite Automata and Regular Expressions.
	UNIT II : Properties of Regular Languages : The Pumping Lemma for Regular Languages – Application of the Pumping Lemma – Closure Properties of Regular Languages – Reversal – Homomorphism – Decision properties of Regular Languages – Converting NFA's to DFA'S – Minimization of DFA's.
	UNIT III : Context Free Grammars and Languages : Context Free Grammars – Parse Trees – Normal forms for Context Free Grammars – Chomsky Normal Form – Greibach Normal Form.
	UNIT IV: Pushdown Automata :Definition – The languages of a PDA – Equivalence of PDA's and CFG's – Deterministic Pushdown Automata
	UNIT V: Properties of Context-Free Languages : The Pumping Lemma for Context-free Languages – Closure Properties of Context- Free Languages – Decision properties of CFL's.
Extended Professional Component	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text	1. –Introduction to Automata Theory Languages and Computation‖. Hopcroft H.E. and Ullman J. D. Pearson Education. 2. Introduction to Theory of Computation - Sipser 2nd edition Thomson

Reference Books	1. John . E. Hopcraft, Rajeev Motwani and Jeffrey D. Ullman, Introduction to Automata Theory, 2. Languages and Computation, Pearson Education, 2013. 3. A Salomaa , Formal Languages , Academic press , New York , 1973 4. John C. Martin, Introduction to Languages and theory of Computations (2nd Edn), Tata – McGraw Hill company Ltd., New Delhi, 1997. 5. Dr. Rani Siromoney , Formal Languages and Automata, The Christian Literature Society, 1979.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

Course Learning Outcome (for Mapping with POs and PSOs)

Student will have the ability to

1. gain knowledge of fundamental concepts of automata.
2. properties of regular languages.
3. push down automata and context free languages.

Title of the Course		**PROGRAMMING IN C++ AND NUMERICAL ANALYSIS**					
Paper Number		**ELECTIVE**					
Category	Elective	**Year**	I	**Credits**	3	**Course Code**	
		Semester	I				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		3	1		--	4	
Objectives of the Course		This course introduces a higher level language C++ and numerical methods for hands-on experience on computers. Stress is also given on the error analysis.					
Course Outline		**UNIT-I** Principles of OOP-Tokens-Expressions, Control Structures-Functions-Classes and Objects-constructors and destructors. Chapter 1 to 6					
		UNIT-II Operator Overloading and type Conversions - Inheritance - Pointers, Virtual Functions and Polymorphism-Managing Console I/O Operations-Working with Files . Chapter 7 to 11					

	UNIT-III Finite Digit Arithmetic and Errors Floating point arithmetic - Propagated Error - Generated Error - Error in Evaluation of a function f(x). - Non-linear Equations: Bisection method- Secant Method - Regula Falsi Method - Newton‘s method - Muller‘s method - Fixed Point method - Chapters 1,2 : Only 2.1 to 2.6
	UNIT-IV System of Linear Equations Gauss- Elimination Method - Crout‘s method - Inverse of a matrix - Condition numbers and errors - Jacobi‘s method - Gauss-Seidel Method - Relaxation method. Numerical Differentiation and Integration: Numerical Differentiation - Numerical Integration - Newton-Cotes Formulas - Gaussian Quadrature - Double Integral Chapter 3 and 5 : 5.1 to 5.5 and 5.7 (omit 5.6)
	UNIT V Ordinary Differential Equations: Difference equation - Differential Equations:Single Step method-Runge-Kutta Method-Multi-step methods Chapter 6: 6.1 to 6.4 (omit 6.5)
Extended Professional Component	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency,Professional Communication and Transferrable Skill
Recommended Text	1. E. Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill, New Delhi, 1999. 2. Devi Prasad, An Introduction to Numerical Analysis (3rd edn) Narosa Publishing House, New Delhi, 2006.
Reference Books	1. D. Ravichandran, Programming with C++, Tata McGraw Hill, New Delhi, 1996 2. Conte and de Boor, Numerical Analysis, McGraw Hill, New York, 1990 3. John H.Mathews, Numerical Methods for Mathematics, Science and Engineering (2nd Edn.), Prentice Hall, New Delhi, 2000
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

Group B: **(PM/AP/IC/ITC)**

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">LIE GROUPS and LIE ALGEBRAS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">ELECTIVE</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td>Credits</td><td>3</td><td>Cours eCode</td><td></td></tr>
<tr><td>Semester</td><td>I</td><td colspan="4"></td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td colspan="2"></td><td>3</td><td colspan="2">1</td><td>--</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">UG level linear algebra and matrix groups.</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">1. In physics, Lie groups appear as symmetry groups of physical systems, and their Lie algebras (tangent vectors near the identity)may be thought of as infinitesimal symmetry motions.
2. Lie algebras and their representations are used extensively in physics,
notably in quantum mechanics and particle physics.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="7">UNITI:Matrix Lie Groups
Chapter 1</td></tr>
<tr><td colspan="7">UNITII:The Matrix Exponential
Chapter 2</td></tr>
<tr><td colspan="7">UNITIII:Lie Algebras
Chapter 3</td></tr>
<tr><td colspan="7">UNITIV:Basic Representation Theory
Chapter 4</td></tr>
<tr><td colspan="7">UNITV:Semisimple Lie Algebras
Chapter 7</td></tr>
<tr><td colspan="2">Extended Professional Component</td><td colspan="7">Questions related to the above topics, from various competitive examinationsUPSC / TNPSC / others to be solved
(To be discussed during the Tutorial hour)</td></tr>
<tr><td colspan="2">Skills acquired fromthis course</td><td colspan="7">Knowledge, Problem Solving, Analytical ability, Professional Competency,Professional Communication and Transferrable Skill</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="7">1. Brain Hall, Lie Groups, Lie Algebras and Representations: An Elementary Introduction (Second Edition), Springer, USA, 2015.</td></tr>
</table>

Reference Books	1. V. S. Varadarajan, Lie groups, Lie algebras and their representations,Sringer 1984. 2. Brian Hall, Lie groups, Lie algebras and representations, Springer2003. 3. Barry Simon, Representations of finite and compact groups, AMS1996. 4. A. W. Knapp, Representation theory of semismiple Lie groups. Anoverview based on examples, Princeton university press 2002. 5. S. Kumaresan S, A course in differential geometry and Lie groups,Texts and Readings in Mathematics, 22. Hindustan Book Agency, New Delhi, 2002.

Website and e-Learning Source	1. https://archive.nptel.ac.in/courses/111/108/111108134/ 2. https://www.digimat.in/nptel/courses/video/111108134/L42.html

Title of the Course	**MATHEMATICAL PROGRAMMING**						
Paper Number	**ELECTIVE**						
Category	Elective	**Year**	I	**Credits**	3	**Course Code**	**23PMAE16**
		Semester	I				
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**			
	3	1	--	4			
Objectives of the Course	This course introduces advanced topics in Linear and non-linear Programming						

Course Outline

UNIT-I

INTEGER LINEAR PROGRAMMING : Types of Integer Linear Programming Problems - Concept of Cutting Plane - Gomory's All Integer Cutting Plane Method - Gomory's mixed Integer Cutting Plane method - Branch and Bound Method.

DYNAMIC PROGRAMMING: Characteristics of Dynamic Programming Problem - Developing Optimal Decision Policy - Dynamic Programming Under Certainty - DP approach to solve LPP.

Chapter-7: 7.1 - 7.6 and Chapter-20: 20.1 - 20.5

UNIT-II

CLASSICAL OPTIMIZATION METHODS : Unconstrained Optimization - Constrained Multi-variable Optimization with Equality Constraints - Constrained Multi-variable Optimization with inequality Constraints.

NON-LINEAR PROGRAMMING METHODS: Examples of NLPP - General NLPP -

Graphical solution - Quadratic Programming - Wolfe's modified Simplex Methods.

Chapter-23: 23.1 - 23.4 and Chapter-24: 24.1 - 24.4

UNIT-III : THEORY OF SIMPLEX METHOD

Canonical and Standard form of LP - Slack and Surplus Variables - Reduction of any Feasible solution to a Basic Feasible solution - Alternative Optimal solution - Unbounded solution - Optimality conditions - Some complications and their resolutions

	- Degeneracy and its resolution Chapter-25: 25.1 - 25.4, 25.6-25.9
	UNIT-IV REVISED SIMPLEX METHOD : Standard forms for Revised simplex Method - Computational procedure for Standard form I - comparison of simplex method and Revised simplex Method. BOUNDED VARIABLES LP PROBLEM: The simplex algorithm Chapter-26: 26.1 - 26.4 Chapter-28: 28.1, 28.2
	UNIT-V PARAMETRIC LINEAR PROGRAMMING : Variation in the coefficients c_j , Variations in the Right hand side, b_i . GOAL PROGRAMMING : Difference between LP and GP approach - Concept of Goal Programming - Goal Programming Model formulation - Graphical Solution Method of Goal Programming - Modified Simplex method of Goal Programming. Chapter-29: 29.1 - 29.3. Chapter-8: 8.1 - 8.4, 8.6 and 8.7.
Extended Professional Component	Questions related to the above topics, from various competitive examinations UPSC / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text	1.J.K.Sharma, Operations Research, Theory and Applications, Third Edition (2007) Macmillan India Ltd.
Reference Books	1. Hamdy A. Taha, Operations Research, (seventh edition) Prentice - Hall of India Private Limited, New Delhi, 1997. 2. S.S. Rao - Optimization Theory and Applications, Wiley Eastern Ltd. New Delhi. 1990.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

Title of the Course		**FUZZY SETS AND THEIR APPLICATIONS**					
Paper Number		**ELECTIVE**					
Category	Elective	**Year**	I	**Credits**	3	**Cours eCode**	
		Semester	I				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		3	1		--	4	
Objectives of the Course		Fuzzy is one of the latest topic in Mathematics that has real life applications. Hence it is essential for the students to learn this topic. This topic introduces the concept of uncertainty and fuzziness in logic that will enable the student to develop their intuitive mind further. The two years M.Sc. program is to prepare every student to face the competitive world outside.It will help them toacquire sufficient knowledge and skill in the subject that will make them competent in various areas of mathematics.					
Course Outline		UNIT I: Crisp sets and fuzzy sets: Overview of Classical Sets, Membership Function, Height of a fuzzy set – Normal and sub normal fuzzy sets – Support – Level sets, fuzzy points, □–cuts – Decomposition Theorems, Extension Principle.					
		UNIT II : Operation on fuzzy sets: Standard fuzzy operations – Union, intersection and complement – properties De. Morgan's laws - □–Cuts of fuzzy operations.					
		UNIT III : Fuzzy relations: CartesianProduct, Crisp relations – cardinality – operations and properties of Crisp and Fuzzy relations.Image and inverse image of fuzzy sets - Various definitions of fuzzy operations – Generalizations – Non interacting fuzzy sets, Tolerance and equivalence relations.					

	UNIT IV : Decision making in Fuzzy environments: General Discussion – Individual Decision making – multi person decision making – multi criteria decision making – multi stage decision making – fuzzy ranking methods – fuzzy linear programming.
	Unit V : Applications: Medicine – Economics – Fuzzy Systems and Genetic Algorithms – Fuzzy Regression – Interpersonal Communication – Other Applications.
Extended Professional Component	Questions related to the above topics, from various competitive examinations UPSC / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1. G.J. Klir, and Bo Yuan, Fuzzy Sets and fuzzy Logic: Theory and Applications, Prentice Hall of India Ltd., New Delhi, 2005.

Reference Books	1. George J.Klir and Bo Yuan , Fuzzy sets and Fuzzy Logic Theory and Applications, PHI Leaning Private Limited, New Delhi (2009). 2. A. K. Bhargava; Fuzzy Set Theory, Fuzzy Logic and their Applications, published by S. Chand Pvt. Limited (2013). 3. K.Pundir and R.Pundir, Fuzzy sets and their application, Published by A Pragati edition (2012 4. 4.H.J.Zimmermann, Fuzzy set theory and its applications, Springer (2012).
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

Course Learning Outcome (for Mapping with POs and PSOs)

To develop analytical mind so that the students can sharpen their mind better.
To provide with sufficient practical oriented application thus the students can face the competitive world.
To enable the students to have a thorough exposure to the different branches of Mathematics so as to gain a comprehensive knowledge of Mathematics.
To mold the students in research/teaching or to find better placement in corporate sectors.

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">DISCRETE MATHEMATICS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE</td></tr>
<tr><td>Category</td><td>Elective</td><td>Year</td><td>I</td><td>Credits</td><td>3</td><td>Cours eCode</td><td colspan="2"></td></tr>
<tr><td colspan="2"></td><td>Semester</td><td>I</td><td colspan="4"></td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2"></td><td colspan="2">3</td><td colspan="2">1</td><td colspan="2">--</td><td>4</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">1 Introduce the algebraic structures of lattices and Boolean algebra.
2 Construct the switching circuits with applications.
3 Educate the finite fields and its mathematics properties.
4 Inculcate the polynomials over finite fields, Irreducibility and factorization of polynomials.
5 Indoctrinate the coding theory with the linear and cyclic codes.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="8">Unit-1: Lattices
Properties and Examples of Lattices – Distributive Lattices – Boolean Algebras – Boolean Polynomials - Minimal Forms of Boolean Polynomials.
Chapter 1: Sections 1–6</td></tr>
<tr><td colspan="2"></td><td colspan="8">Unit-2 :
Switching Circuits – Applications of Switching Circuits.
Chapter 2:Sections 7–8</td></tr>
<tr><td colspan="2"></td><td colspan="8">Unit-3 :
Finite Fields.
Chapter 3:Sections 13</td></tr>
<tr><td colspan="2"></td><td colspan="8">Unit-4 : Polynomials
Irreducible Polynomials over Finite Fields - Factorization of Polynomials over Finite Fields.
Chapter 3:Sections 14–15</td></tr>
</table>

	Unit -5: Linear Codes – Cyclic Codes. Chapter 4:Sections 17–18
Extended Professional Component	Questions related to the above topics, from various competitive examinations UPSC / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	Rudolf Lidl and Gunter Pilz, *Applied Abstract Algebra*, 2nd Indian Reprint, Springer Verlag, New York, 2006.

Reference Books	1. A.Gill, Applied Algebra for Computer Science, Prentice Hall Inc., New Jersey. 2. J.L.Gersting, Mathematical Structures for Computer Science, 3rd Edn., Computer Science Press, New York. 3. S.Wiitala, Discrete Mathematics - A Unified Approach, McGraw Hill Book Co.
Website and e-Learning Source	1. http://www.discrete-math-hub.com/resources-and-help.html 2. https://onlinecourses.nptel.ac.in/noc22_cs123/preview 3. https://onlinecourses.nptel.ac.in/noc22_cs85/preview

Course Learning Outcome

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

CO1 Know the algebraic structures of lattices and Boolean algebra, and sketch the minimization of Boolean polynomials.

CO2 Model the switching circuits with applications.

CO3 Understand the finite fields and its mathematics properties.

CO4 Acquire the notions of the polynomials over finite fields, Irreducibility and factorization of polynomials.

CO5 Apply the coding theory with the linear and cyclic codes in cryptography.