Estd: 1966

SARASWATHI NARAYANAN COLLEGE
(An Autonomous Institution Affiliated to Madurai Kamaraj University)
(Reaccredited with Grade 'B' by NAAC)
Perungudi, MADURAI – 625 022.
Website : www.sncollegemadurai. org
E.mail: sncollegemdu@yahoo.com
Ph.: 0452 2690635 Fax: 0452 2690635

DEPARTMENT OF MATHEMATICS

Choice Based Credit System (CBCS)
Learning Outcomes-based Curriculum Framework (LOCF)
M.Sc. Mathematics Programme
(For those who join in June 2022)

PRINCIPAL

Dr. M. Kannan M.A., M.Phil., Ph.D.

DEPARTMENT OF MATHEMATICS

1. Dr. K.Muthukumaran, M.Sc., M.Phil., Ph.D.
- Associate Professor and Head
2. Dr. Dr. P. Veerammal, M.Sc., M.Phil., Ph.D.
- Assistant Professor
3. Dr. A. Wilson Baskar, M.Sc., M.Phil., Ph.D.
- Assistant Professor
4. Dr. S.V. Padmavathi, M.Sc., M.Phil., Ph.D.
- Assistant Professor
5. Dr. M. Kalanithi, M.Sc., M.Phil., Ph.D.
- Assistant Professor
6. Dr. A. Meena, M.Sc., M.Phil., Ph.D.
- Assistant Professor
7. Dr. K. Angaleeswari, M.Sc., M.Phil., Ph.D.
- Assistant Professor
8. Dr. N.Deena, M.Sc., M.Phil., Ph.D.
- Assistant Professor

PROFILE OF THE COLLEGE

Thiru. L. Narayanan Chettiar, a renowned philanthropist founded Saraswathi Narayanan College at Perungudi near Madurai Airport in the year 1966. The college is a prestigious academic powerhouse catering to the educational needs of students hailing from economically weaker and socially oppressed section of our society. It imparts education of the highest quality to students irrespective of caste, creed and religion. The guiding principles of our college are duty, devotion and distinction. The institution has proved an innovative leader and a catalyst in the best educational, cultural and economic interests of students. It is committed to make the students morally upright, intellectually resourceful, socially advantaged and globally competent. It is devoted to teaching, research and extension activities with equal importance.

The college set off its academic journey with Pre-University Courses in the year 1966 – 67. The Institution started offering UG programmes from the academic year 1968 – 69. It was upgraded as Post-Graduate Institution in 1979 – 80 and as Research Institution in 1984 – 85. The co-educational system was introduced for M.Phil. programmes in the academic year 2001 – 02 and for PG programmes in the year 2002 – 03 with the noble objective of promoting higher education among girls in rural areas. Girls have been enrolled in UG programmes also since the academic year 2010 – 11.

The green campus of 66 acres has a built-up area of 1,70,059 sq.ft. A new library housed at Silver Jubilee building was built at the cost of Rs.25,00,000/- and it was inaugurated by His Excellency Dr. M. Chenna Reddy, then the Governor of Tamilnadu on 04.04.1994. The library was dedicated to the memory of Achi. The major donor of this building was Tmt. Saraswathi Narayanan, the better half of the Founder President Thiru. L. Narayanan Chettiar. Sri Vidhya Ganapathi Temple was built and consecrated on 27.08.2015.

The Departments of Botany, Mathematics, Commerce, English, Economics and Chemistry have been upgraded as university recognized research centres to carryout M.Phil and Ph.D research programmes in the college. NAAC accredited the college with grade B+ in the year 2005. UGC accorded the status of Autonomy to our institution in the year 2007. NAAC re-accredited the college with grade B (CGPA of 2.78) in the year 2016. UGC extended the Status of Autonomy to the institution for another period of five years from the academic year 2016 – 17.

M. Sc [Mathematics] – Course Structure

Course type	Title of the course	Course Code	H/ W	Credit	Exam Hrs.	Int	Ext
SEMESTER I							
CC-1	Differential Geometry	LPMSCT11	6	4	3	25	75
CC-2	Graph theory	LPMSCT12	6	4	3	25	75
CC-3	Groups and Rings	LPMSCT13	6	5	3	25	75
CC-4	Analysis - I	LPMSCT14	6	5	3	25	75
DSE-11	Classical Mechanics	LPMSDS11 LPMSDS12	6	5	3	25	75
DSE- 12	Numerical Analysis						
Ad. Cr. Co: MOOC			-	-	-	-	-
			30	22			
SEMESTER II							
Course type	Title of the course	Course Code	H/ W	Credit	Exam Hrs.	Int	Ext.
CC-5	Linear Algebra	LPMSCT21	6	5	3	25	75
CC-6	Analysis - II	LPMSCT22	6	4	3	25	75
CC-7	Topology	LPMSCT23	5	4	3	25	75
CC-8	Differential Equations	LPMSCT24	6	4	3	25	75
DSE-21	Optimization Techniques	LPMSDS21 LPMSDS22	5	3	3	25	75
DSE-22	Algorithmic Graph theory						
AEC-1	Combinatorial Mathematics	LPMSAE21	2	2	3	25	75
SLC-11	Fuzzy Set theory and it's Applications	LPMSSC21	-	-	2	50	100
SLC -12	Graph Theory and its Applications	LPMSSC22					
Ad. Cr. Co: MOOC	MOOC-1		-	-	-	-	-
			30	22			

Course type	Title of the course	Course Code	Hrs/ Week	Credit	Exam Hrs.	Int	Ext.
SEMESTER III							
CC-9	Field Theory and Lattice Theory	LPMSCT31	6	5	3	25	75
CC-10	Functional Analysis	LPMSCT32	5	4	3	25	75
CC-11	Statistics - I	LPMSCT33	6	4	3	25	75
CC-12	Measure Theory	LPMSCT34	6	4	3	25	75
GEC-1	Mathematics for Competitive Examinations (NME)	LPMSNM31	5	4	3	25	75
AEC-2	Mathematics for SET/NET/CSIR-UGC	LPMSAE31	2	2	3	25	75
SLC-21	Graphs and Matrices	LPMSSC31	-	-	2	50	100
SLC-22	Graph Theory and Combinatorics	LPMSSC32					
Ad. Cr. Co: MOOC	MOOC-2		-	-	-	-	-
			30	23			
SEMESTER IV							
Course type	Title of the course	Course Code	Hrs/ Week	Credit	Exam Hrs.	Int	Ext.
CC-13	Complex Analysis	LPMSCT41	6	5	3	25	75
CC-14	Number Theory	LPMSCT42	6	5	3	25	75
CC-15	Statistics - II	LPMSCT43	6	4	3	25	75
CC-16	Project	LPMSPJ41	5	4	3	50(p)	50(vv)
DSE-41	Advanced Topology	LPMSDS41	5	3	3	25	75
DSE -43	Modern Applied Algebra	LPMSDS42					
SEC-41	Advanced Functional Analysis	LPMSSE41	2	2	3	25	75
SEC-42	Cryptography and Network Security	LPMSSE42					
Ad. Cr. Co: MOOC	MOOC-2			-	-	-	-
			30	23			

SARASWATHI NARAYANAN COLLEGE
(An Autonomous Institution Affiliated to Madurai Kamaraj University)
(Reaccredited with Grade 'B' by NAAC)
Perungudi, MADURAI – 625 022.

DEPARTMENT OF MATHEMATICS – PG – CBCS - LOCF

(For those who join in June 2022)

Title of the Course: Differential Geometry		**Semester: I**
Course Code: LPMSCT11	**Contact hours: 6hrs/w**	**Credits: 4**

Course Learning Outcomes:

On completion of the course, the students are able to

- understand the importance of Differential Geometry and learn various elementary formulas.
- understand the concepts of Curves with parametric form and Cartesians form.
- gain the knowledge of surfaces.
- apply the properties of Geodesics curvature.
- basic knowledge of developable associated with space curves.

Pre Required Knowledge:

- ✓ Tangent and Normal.
- ✓ Helices and Helicoids.
- ✓ Lines of curvature.

Unit I: Differentiation and concepts of curves

Introductory remarks about space curves, Definitions of arc length, tangent, normal and binomial -curvature and torsion of a curve given as the intersection of two surfaces, contact between curves and surfaces, tangent surface, involutes and evaluates.

Unit II:Locus and fundamental theorem of curves

Intrinsic equations, fundamental existence theorem for space curves, Helices and definition of a surface, curves on a surface, surfaces of revolution, Helicoids.

Unit III:Metric and Geodesics

Metric, direction coefficients, families of curves, – geodesics, canonical geodesic equations, normal property of geodesics.

Unit IV: Gauss- Bonet theorem and Applications

Existence theorems, geodesic parallels, geodesic curvature Gauss- Bonet theorem, Gaussian curvatures - surfaces of constant curvature.

Unit V: Second fundamental form and Developable

The second fundamental form, principal curvatures, lines of curvature, developable, developable associated with space curves, developable associated with curves on surfaces, minimal surfaces, ruled surfaces.

Suggested Topics for Group Discussion/ Presentation:

1. Curvature and torsion of a curve
2. Fundamental existence theorem for space curves
3. Canonical geodesic equations
4. Bonet theorem
5. Lines of curvature.

Suggested Readings:

(i) Text Book:

T.J. Wilmore, An Introduction to Differential Geometry, Oxford University Press, NewYork, 1983

Unit I: Chapter 1 : sections 1 to 7

Unit II: Chapter 1 : sections 8 and 9, Chapter 2 : sections 1 to 4

Unit III: Chapter 2 : sections 5 to 7 and 10 to 12

Unit IV: Chapter 2 : sections 13 to 18

Unit V: Chapter 3 : sections 1 to 8

(ii) Reference books:

1. P.P.Gupta, G.S.Malik, Three dimensional Differential Geometry, Pragati Prakasham, Twelfth edition, New Delhi 2005.
2. Mittal Agarwal, Krishna's Differential Geometry, Kirshna Prakash, Media private Limited, New Delhi, 2007.
3. C.E.Weatherburn, "Differential Geometry of Three Dimensions", University Press, Cambridge,1930.

(iii) Web Resources:

1. http://www-math.mit.edu/~djk/18_022/chapter02/section07.html
2. https://www.sciencedirect.com/topics/mathematics/gauss-bonnet-theorem
3. https://web.mit.edu/hyperbook/Patrikalakis-Maekawa-Cho/node190.html

---

Title of the Course: Graph Theory

Course Code: LPMSCT12 Contact hours: 6hrs/w Credits: 4

Course Learning Outcomes:

On completion of the course, the students are able to

- understand the concepts of Matchings and Colourings.
- relate connectivity concepts in the theory of network flow problems.
- formulate and prove central theorems about trees, matchings, connectivity and colourings.
- analyze and apply planarity concepts in computer graphics.
- develop graphical solutions to real life problems**.**

Pre required knowledge:

- ✓ Graphs and Matrices.
- ✓ Connectedness in Graph Theory.
- ✓ Coloring in Graphs.

Unit I: Graphs and Connected graphs

Graphs – Connected graphs – Classes of graphs – Multi graphs and digraphs - The degree of a vertex – Regular graphs – Degree sequences – Graphs and matrices.

Unit II: Isomorphic graphs

Isomorphism of graphs - Bridges – Trees – The minimum spanning tree problem.

Unit III: Trees

Cut-vertices – Blocks – Connectivity – Menger's theorem - Eulerian graphs.

Unit IV: Traversability

Hamiltonian Graphs - Matchings and 1-Factorization– Planar graphs.

Unit V: Colouring

The Four colour problem – Vertex colouring – Edge colouring – Five colour Theorem – The centre of a graph.

Suggested Topics for Group Discussion/ Presentation:

1. Degree Sequences
2. Isomorphism of graphs
3. Blocks
4. 1-Factorization
5. Five Color Theorem

Suggested Readings:

(i) Text Book:

Gary Chartrand and Ping Zhang, ***Introduction to GraphTheory***, Tata McGraw-Hill, New Delhi, 2006.

Unit I: Sections 1.1 to 1.4, 2.1 to 2.4.

Unit I: Sections 3.1, 4.1 to 4.3

Unit III: Sections 5.1 to 5.4, 6.1.

Unit IV: Sections 6.2, 8.1, 8.2(up to Theorem 8.15 only), 9.1

Unit V: Sections 10.1 to 10.3,10.4(Theorem 10.19 only), 12.1

(ii) Reference books:

1. R. Balakrishnan and K. Ranganathan, Text Book: of Graph Theory, Springer, 2000.
2. Robin .J. Wilson, Introduction to Graph Theory, Fourth Edition, Pearson Education,
3. Narasimha Deo, Graph Theory with Applications to Engineering and Computer Science.
4. Harary F, Graph Theory, Addison- Wesley, Reading Mass, 1969.
5. D.B West, Introduction to graph theory, Prentice Hall of India, 2001.

(iii) Web Resources:

1. https://mathworld.wolfram.com/EulerianGraph.html
2. https://nrich.maths.org/6291
3. https://mathworld.wolfram.com/Four-ColorTheorem.html

Title of the Course: Groups and Rings

Course Code: LPMSCT13 Contact hours: 6hrs/w Credits: 5

Course Learning Outcomes:

On completion of the course, the students are able to

- find the number of sylow' subgroups in a group,
- examine advanced ideas in the algebraic structures,
- recognize the development of rational number system,
- find the number of non isomorphic abelian groups of given order.
- solve the irreducibility of polynomials

Pre Required Knowledge:

- ✓ Set theory, Relation, equivalence relation and equivalence classes
- ✓ Group and subgroup,
- ✓ normal subgroup and quotient group.

Unit I: Homomorphisms and conjucate classes

Homomorphisms- Automorphisms- Another counting principle.

Unit II: Existence of Subgroups, and Products of groups

Sylow's Theorem- Direct products, Finite Abelian groups.

Unit III: Ring Theory

Ideals and Quotient Rings - More Ideals and Quotient Rings - The Field of Quotients of an Integral domain

Unit IV: Euclidean Rings

Euclidean Rings - A particular Euclidean Ring

Unit V: Polynomial Rings

Polynomial Rings - Polynomial over the Rational Field - Polynomial rings over Commutative Rings.

Suggested Topics for Group Discussion/ Presentation:

1. Automorphisms
2. Direct products
3. Ideals
4. Euclidean Rings
5. Polynomial rings

Suggested Readings:

(i)Text Book:

N. Herstein, Topics in Algebra, Second Edition, John Wiley and sons, 1999.

Unit – 1 (Chapter2: Sections 2.7,2.8,2.11)

Unit – 2(Chapter2: Sections 2.12, 2.13, 2.14)

Unit – 3 (Chapter3: Sections 3.4, 3.5, 3.6)

Unit – 4 (Chapter3: Sections 3.7, 3.8)

Unit – 5 (Chapter3: Sections 3.9, 3.10, 3.11)

(ii) Reference books:

1. Surjeet Singh and QaziZameeruddin, Modern Algebra, Vikas Publishing House Pvt. Ltd., New Delhi, 2015.
2. S. Lang, *"Algebra*", 3rd Edition, Addison-Wesley, Mass, 1993.

3. Vijay K Khanna and S.K. Bhambri, A course in Abstract Algebra, Vikas Publishing House Pvt. Ltd., New Delhi, 2015.
4. Richard M. Foote and David S. Dummit, Abstract Algebra, John Wiley Publications, New York, 2011.
5. Joseph A Gallian, Contemporary Abstract Algebra, Narosa Publication, New Delhi, 1999.
6. John B. Fraleigh, *"A First Course in Abstract Algebra",* Addison Wesley,Mass, 1982.
7. M. Artin, *"Algebra",* Prentice-Hall of India, New Delhi, 1991.

(iii) Web Resources:

1. http://homepages.warwick.ac.uk/~masdf/alg2/ln_2011.pdf
2. http://www2.math.uu.se/~khf/dachs.pdf
3. https://users.metu.edu.tr/matmah/Graduate-Algebra-Solutions/Undergraduate-Algebra-Problems%20and%20Solutions.pdf
4. http://www.csun.edu/~asethura/GIAAFILES/GIAAV1.0/GIAAV1.0.pdf
5. https://www.math.mcgill.ca/goren/Algebra3.2004/CourseNotes.pdf
6. http://www.freebookcentre.net/Mathematics/Abstract-Algebra-Books.html

---

Title of the Course: Analysis – I **Semester: I**

Course Code: LPMSCT14 **Contact hours: 6hrs/w** **Credit: 5**

Course Learning Outcome:

On completion of the course, the students are able to

- understand and classify countable and uncountable sets.
- analyse metric spaces, compact sets, connected sets, and to examine those spaces
- test convergence of sequences, Cauchy sequences and use various tests like the Root Test and Ratio Test

- understand series, series of nonnegative terms, the Number e
- classify and examine the continuity and differentiability of functions.

Pre Required Knowledge:

- ✓ Basic Concepts of Metric Spaces
- ✓ Fundamental results of sequences and series
- ✓ Basic concepts of continuity and differentiability

Unit I: Basic Topology

Finite, Countable and uncountable sets, Metric spaces

Unit II: Basic Topology Continued and Numerical Sequences

Compact Sets, Perfect Sets, Connected Sets, Convergent Sequences, Sub Sequences, Cauchy Sequences, upper and lower limits, some special Sequences.

Unit III: Numerical Series

Series, Series of Nonnegative Terms, The Number e, The Root and Ratio Tests, Power Series, Summation by parts, Absolute Convergence, Addition and multiplication of series, Rearrangement

Unit IV: Continuity

Limits of functions, continuous functions, continuity and compactness, continuity and connectedness, Discontinuities, monotonic functions, infinite limits and limits at infinity

Unit V: Differentiation

The derivative of a real function, Mean value theorems, The Continuity of derivatives, L'Hospital's rule. Derivatives of higher order, Taylor's theorem, Differentiations of vector-valued functions.

Suggested Topics for Group Discussion/ Presentation

1. Countability
2. K-cell
3. Root test
4. Ratio test

5. Continuity on compact sets
6. Mean Value theorem

Suggested Readings:

(i) Text Book:

Walter Rudin, Principles of Mathematical Analysis, McGraw Hill Education (India) Edition, 2013.

Unit – 1: Chapter 2: Sections 2.1 to 2.30

Unit – 2: Chapter 2: Sections 2.31 to 2.47 and Chapter 3: sections 3.1 to 3.20

Unit – 3: Chapter 3: Sections 3.21 to 3.55

Unit – 4: Chapter 4: Sections 4.1 to 4.34

Unit – 5: Chapter 5: Sections 5.1 to 5.19

(ii) Reference books:

1. Tom M Apostol, Mathematical Analysis, 2nd Edition, Narosa Publishing house, 2002.
2. H.L.Royden, Real Analysis, Macmillan Publishing Company,1987
3. S.C. Malik, Principles of Real Analysis, New Age International Publishers,1996

(iii) Web Resources:

1. https://www.youtube.com/watch?v=knxW5kftXwk
2. https://www.youtube.com/watch?v=6IxS342xH4Y
3. https://www.youtube.com/watch?v=F8pP0NLGkb4
4. https://www.youtube.com/watch?v=AqHxSRuI-Ck
5. https://www.youtube.com/watch?v=GMyQRRmUSWY
6. https://nptel.ac.in/courses/111/106/111106053/
7. https://ocw.mit.edu/courses/mathematics/18-101-analysis-ii-fall-2005/lecture-notes/

Title of the Course: Classical Mechanics		Semester: I
Course Code: LPMSDS11	Contact hours: 6hrs/w	Credit: 4

Course Learning Outcome:

On completion of the course, the students are able to

- understand the foundation of basic principles of mechanics and some classical problems.
- explain the concepts of Lagrangian and Hamiltonian formulations of classical mechanics.
- understand the Hamilton principle and simple applications Lagrange's equation
- apply the planetary motion of Newton's laws, Kepler Problems.
- understand the applications of Kepler's problem.

Pre Required Knowledge:

- ✓ The basic formulae for velocity.
- ✓ Learn the central force.
- ✓ Fundamental knowledge of differential calculus.

Unit I: Survey of elementary principles:

Mechanics of a particle, Mechanics of a system of particles, Constraints,D' Alembert's Principle and Lagrange's equation

Unit II: Lagrange's equation and properties

Velocity-dependent potential and the dissipation function, simple applications of the Lagrange's equation Hamilton's Principle, Techniques of the calculus of variation.

Unit III: Hamilton's principle

Derivation of Lagrange's equation from Hamilton's principle, Extension of Hamilton's principle of nonholonomic system, Advantage of a variational principle formulation, Conservation theorems and symmetry properties.

Unit IV: Classification of orbits

The Two – Body central force Problem-Reduction to the equivalent one-body problem, the equation of motion and first integrals, the equivalent one-dimensional problem and classification of orbits. The Virial theorem.

Unit V: Applications of differential equations.

The differential equation for the orbit and integrable power-law potentials, Conditional for closed orbits - Bertrand's theorems, The kepler problem, Inverse square law of force, The motion in time in the kepler problem, The Laplace-Runge-Lenz vector.

Suggested Topics for Group Discussion/ Presentation:

1. D' Alembert's Principle
2. Lagrange's equation Hamilton's Principle
3. Extension of Hamilton's principle of non-holonomic system
4. Body central force Problem
5. Bertrand's theorems

Suggested Readings:

(i) Text Book:

H. Goldstein,Classical Mechanics, Addison Wesley, second edition, New York, 1980.

Unit I: (Chapter 1: sections 1.1 to 1.4)

Unit II: (Chapter 1: sections 1.5,1.6 and Chapter 2: sections 2.1, 2.2)

Unit III: (Chapter 2: sections 2.4 to 2.6)

Unit IV: (Chapter 3: sections 3.1 to 3.4)

Unit V: (Chapter 3: sections 3.5 to 3.9)

(ii) Reference books:

1. S.L Gupta, V. Kumar, H.V Sharma, Classical Mechanics, PragathiPrakashan, New Delhi 1972.
2. Murray R.Spiegel, Theory and Problems of Theoretical Mechanics, McGraw-Hill Book Company,1982.
3. D.E.Rutherford, Classical Mechanics, Interscience Publishers,1964.

(iii) Web Resources:

1. https://phys.libretexts.org/Bookshelves/Classical_Mechanics/Variational_Principles_in_Classical_Mechanics_(Cline)

/06%3A_Lagrangian_Dynamics/6.03%3A_Lagrange_Equations_from_dAlemberts_Principle

2. https://phys.libretexts.org/Bookshelves/Classical_Mechanics/Variational_Principles_in_Classical_Mechanics_(Cline)/06%3A_Lagrangian_Dynamics/6.04%3A_Lagrange_equations_from_Hamiltons_Principle
3. https://www.brainm.com/software/pubs/physics/Virial_theorem.pdf

---

Title of the Course: Numerical Analysis **Semester: I**

Course Code: LPMSDS12 **Contact Hours: 6hrs/w** **Credits: 4**

Course Learning Outcomes:

On completion of the course, the students are able to

- apply the various methods to solve problems.
- find Eigen values and Eigen vectors.
- apply interpolation techniques.
- analyze and Apply numerical differentiation and numerical integration.
- develop difference equation.

Pre Required Knowledge:

- ✓ Algebraic expressions and algebraic equations
- ✓ Basics of differentiation and integration
- ✓ Simple arithmetic calculations

Unit I: Transcendental and polynomial equations

Iteration methods based on first degree equation, iteration methods based on second degree equation, Rate of convergence, General iteration methods.

Unit II: System of linear algebraic equations and Eigen value problems

Iteration methods, Eigen values and eigen vectors, bounds an eigen values.

Unit III: Interpolation

Hermite interpolation, Piecewise and Spline interpolation, Bivariate interpolation.

Unit IV: Differentiation and integration

Numerical differentiation, Extrapolation methods, Partial differentiation, Numerical integration, Composite integration methods, Romberg method.

Unit V: Ordinary differential equations : Initial value problems

Difference equation - Numerical methods.

Suggested Topics for Group Discussion/ Presentations:

1. Iteration methods
2. Eigen values and Eigen vectors
3. Interpolation
4. Numerical Differentiation and integration
5. Difference Equations

Suggested Readings:

(i)Text Book:

M.K. Jain S.R.K.Iyengar and R.K. Jain,Numerical methods for scientific and Engineering Computation Fourth edition, New Age International Publishers, 2003.

Unit 1 - Chapter 2 : Sections 2.1,2.3, 2.4,2.5,2.6.

Unit 2 - Chapter 3 : Sections 3.1,3.4,3.5,3.6.

Unit 3 - Chapter 4: Sections 4.1,4.5,4.6,4.7.

Unit 4 – Chapter 5 : Sections 5.1,5.2,5.4,5.5,5.6,5.9,5.10.

Unit 5 :Chapter 6 : Sections 6.1 to 6.3.

(ii) Reference books:

1. Radhey S. Gupta, Elements of Numerical Analysis, Macmillan, 2009.
2. Radha Kanta Sarkar, Numerical Methods for Science and Engineering, Pentagon Graphics Private Limited, 2004.
3. J.Stoer and R.Bulrisch, Introduction to Numerical Analysis, Springer International Edition, 2012.

(iii) Web Resources:

1. http://www.freebookcentre.net/Mathematics/Numerical-Analysis-Books.html
2. https://nptel.ac.in/courses/111/106/111106101/
3. https://nptel.ac.in/courses/111/107/111107105/
4. http://www.math.iitb.ac.in/~baskar/book.pdf

Title of the Course: Linear Algebra **Semester: II**

Course Code: LPMSCT21 **Contact hours: 6hrs/w** **Credit: 5**

Course Learning Outcome:

On completion of the course, the students are able to

- recall and demonstrate the concepts of vector spaces, subspaces and inner product spaces.
- apply principles of matrix algebra to find properties of linear transformations.
- find the minimal polynomials, Jordan forms and the rational forms of real matrices.
- determine canonical forms and nilpotent transformations.
- demonstrate the Hermitian, Unitary and normal transformations.

Pre Required Knowledge:

- ✓ Concepts of vector spaces, subspaces and inner product spaces.
- ✓ Types of matrices.
- ✓ Fundamental knowledge of matrix and its transformations.

Unit I: Vector spaces

Vector spaces and modules - Elementary Basic concepts- Linear independence and Bases- Dual spaces, Inner product spaces.

Unit II: Modules and linear transformations

Modules, The Algebra of linear transformations, Characteristic roots, Matrices.

Unit III: Canonical Forms

Canonical forms, Canonical forms, Nilpotent tranformations, A decomposition of V: Jordan form.

Unit IV: More on Canonical Forms

Canonical forms: Rational canonical form, Trace and Transpose.

Unit V: Special types of transformations

Determinants, Hermitian, Unitary and Normal Transformations, Real Quadratic forms

Suggested Topics for Group Discussion/ Presentation

1. Vector spaces
2. Modules and Characteristic roots
3. Canonical forms - Canonical forms and Rational canonical form
4. Properties of Determinants
5. matrix algebra and its transformations

Suggested Readings:

(i) Text Book:

I.N. Herstein, Topics in Algebra Second edition, John Wiley and sons, 1999.

Unit 1 Chapter 4: Sections 4.1 to 4.4

Unit 2 Chapter 4: Sections 4.5, Chapter 6 : sections 6.1, 6.2, 6.3

Unit 3 Chapter 6: Sections 6.4, 6.5, 6.6

Unit 4 Chapter 6: Sections 6.7, 6.8

Unit 5 Chapter 6: Sections 6.9, to 6.11

(ii) Reference books:

1. Schaum ‘s outlines, Theorems and problems of linear algebra, 3rd edition ,HoffmanTata McGraw – Hill publishing company limited, New Delhi, 2005.
2. Joseph A Gallian, Contemporary Abstract Algebra, Narosa Publication, New Delhi, 1999.
3. Vijay K Khanna and S.K. Bhambri, 2012, A course in Abstract Algebra Vikas Publishing House Pvt. Ltd., Chennai.

(iii) Web Resources:

1. https://link.springer.com/chapter/10.1007/978-1-4612-0923-2_3#:~:text=Modules%20are%20a%20generalization%20of,ring%2C%20rather%20than%20a%20field.
2. https://www.khanacademy.org/math/linear-algebra/vectors-and-spaces/linear-independence/v/linear-algebra-introduction-to-linear-independence
3. https://www.youtube.com/watch?v=fEXLmsVn0Rw
4. https://sites.math.northwestern.edu/~scanez/courses/334/notes/dual-spaces.pdf
5. https://www.physicsforums.com/threads/inner-products-and-the-dual-space.735158/
6. https://www.youtube.com/watch?v=XFoOlAGeNZM
7. http://www2.econ.iastate.edu/classes/econ671/hallam/documents/Char_Vec_001.pdf
8. https://www.youtube.com/watch?v=gSOSsWufHt0
9. https://www.youtube.com/watch?v=FYB8ExwTjrg
10. https://www.youtube.com/watch?v=a4ApSul2gI0
11. https://www.youtube.com/watch?v=Rsy0dpFxKT8
12. https://www.bmscw.edu.in/files/StudyMaterials/Mathematics/I-Mathematics/Canonical%20form1.pdf
13. https://www.youtube.com/watch?v=460OLs22nG8
14. https://www.youtube.com/watch?v=_VycKaNbKbU
15. http://linearalgebra.math.umanitoba.ca/math1220/section-19.html
16. https://www.math.purdue.edu/~eremenko/dvi/lect3.26.pdf
17. http://www.rmi.ge/~kade/LecturesT.Kadeishvili/MathEconomics/Term3/Week3QuadraticLEC.pdf
18. https://www.youtube.com/watch?v=xsaMDSvVY_M

Title of the Course: Analysis – II **Semester: II**

Course Code: LPMSCT22 **Contact hours: 6hrs/w** **Credit: 4**

Course Learning Outcome:

On completion of the course, the students are able to

- analyse the Riemann Integrable Functions, Riemann Stieltjes Integrable Functions and Rectifiable curves.
- examine Uniform convergence, and Equicontinuous families of functions.
- examine The Stone-Weierstrass Theorem.
- understand the Algebraic completeness of the complex field, Fourier series, The Gamma, function, Linear transformations.
- know how to apply the contraction principle, the inverse function theorem and the implicit function theorem.

Pre Required Knowledge:

- ✓ Basic concepts of integration
- ✓ Convergence of a sequence of functions
- ✓ Basic concepts of exponential, logarithmic and trigonometric functions

Unit I: The Riemann- Stieltjes Integral

Definitions and existence of the integral, Properties of the Integral, Integration and Differentiation, Integration of vector-valued functions, Rectifiable curves.

Unit II: Sequences and Series of Functions

Discussion of the main problem, Uniform convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and Differentiation, Equicontinuous families of functions

Unit III: Some Special Functions

The Stone-Weierstrass Theorem, Power series, The exponential and logarithmic functions, The trigonometric functions

Unit IV: Some Special Functions Continued and Functions of Several Variables

The Algebraic completeness of the complex field, Fourier series, The Gamma function, Linear transformations.

Unit V: Functions of Several Variables Continued

Differentiation, The contraction principle, The inverse function theorem. The implicit function theorem

Suggested Topics for Group Discussion/ Presentation

1. Riemann Stieltje's Integral
2. Uniform convergence
3. Power series
4. Fourier series
5. Contraction principle

Suggested Readings:

(i) Text Book:

Walter Rudin, Principles of Mathematical Analysis , McGraw Hill Education (India) Edition, 2013.

Unit 1: Chapter 6 : Sections 6.1 to 6.27

Unit 2: Chapter 7 : Sections 7.1 to 7.25

Unit 3: Chapter 7 : Sections 7.26 to 7.33, Chapter 8 : sections 8.1 to 8.7

Unit 4: Chapter 8 : Sections 8.8 to 8.22, Chapter 9 : Sections 9.1 to 9.9

Unit 5: Chapter 9 : Sections 9.10 to 9.29

(ii) Reference books:

1. G.F.Simmons, Introduction to Topology and Modern Analysis, Tata Mcgraw-Hill Publishing Company Ltd, New Delhi, 5th Reprint , 2006.
2. H.L.Royden, Real Analysis, Macmillan Publishing Company,1987
3. S.C. Malik, Principles of Real Analysis, New Age International Publishers, 1996

(iii) Web Resources:

1. https://www.youtube.com/watch?v=s_7dMfUAqZk
2. https://www.mathcity.org/msc/notes/advanced-analysis-iqra-liaqat
3. https://www.youtube.com/watch?v=7AGTSCTqLQI
4. https://www.youtube.com/watch?v=AqHxSRuI-Ck
5. https://www.youtube.com/watch?v=C3PmT6oNEew
6. https://www.youtube.com/watch?v=Y5yEMXZnzYw
7. https://math.okstate.edu/people/lebl/uw522-s12/lec1.pdf

Title of the Course: Topology		**Semester: II**
Course Code: LPMSCT23	**Contact hours: 6hrs/w**	**Credits: 4**

Course Learning Outcomes:

On completion of the course, the students are able to

- construct various topologies on sets and compare them,
- define basis and make use of bases to generate topology and justify connectedness in topological spaces,
- classify and analyze the nature of compact topological spaces in particular on Real line,
- define and Categorize separation axioms on different topological spaces and
- know conditions under which a topological space is metrizable.

Pre-required Knowledge:

- ✓ Set theory, relations,& function,
- ✓ Real numbers, cartesian products,
- ✓ Finite sets, infinite sets, countable and uncountable sets.

Unit I: Topological spaces

Topological spaces – Basis for a topology – The order topology – The product topology on $X \times Y$ – The subspace topology – Closed sets and limit point.

Unit II: Continuous functions and metric topology

Continuous functions – The product topology – The metric topology.

Unit III: Connected spaces and Compact spaces

Connected spaces – Connected spaces on a Real line. Compact spaces – Compact subspaces of a real line – Local compactness.

Unit IV: Countability and Separation Axioms

Countability axioms – The separation axioms – Normal spaces.

Unit V: Countability and Separation Axioms(Continued)

The Urysohn Lemma – Tietze Extension theorem – The Urysohn Metrization theorem – The Tychonoff theorem.

Suggested Topics for Group Discussion/ Presentations:

1. Product topology
2. Continuous functions
3. Connected and Compact spaces
4. Separable and normal spaces
5. Applications of separation axioms

Suggested Readings:

(i)Text Book:

James R.Munkres, Topology, (Second Edition) Pearson Prentice – Hall of India Private Ltd, 2007.

Unit 1: (Sections: 12 to 17)

Unit 2: (Sections 18 to 21)

Unit 3: (Sections 23, 24, 26, 27, 29)

Unit 4: (Sections 30 to 32)

Unit 5: (Sections 33, 34, 35, 37)

(ii)Reference books:

1. G.F.Simmons, Introduction to Topology and Modern Analysis, Tata Mcgraw-Hill Publishing Company Ltd., New Delhi, 5th Reprint, 2006.

2. Fred H.Croom, Principles of Topology, Cengage India Pvt. Ltd., New Delhi 2009.
3. Seymour Lipschutz, Theory and Problems of General Topology, McGraw-Hill Edition, New Delhi. 2006.
4. Chandrasekhara Rao. K.,Topology, Narosa Publishing House, New Delhi, 2012.
5. Chatterjee. D., Topology General & Algebraic, New Age International, Chennai, 2007.
6. Deshpande. J.V., Introduction to Topology, Tata McGraw-Hill, New Delhi, 1998.

(iii) Web Resources:

1. https://www.uni-frankfurt.de/64271720/TopNotes_Spring10.pdf
2. https://home.iitk.ac.in/~chavan/topology_mth304.pdf
3. https://people.math.harvard.edu/~auroux/131f19/Math_131_Notes_Beckham_Myers.pdf
4. https://www.uio.no/studier/emner/matnat/math/MAT4500/h18/dokumenter/topology.pdf
5. http://www.mdudde.net/books/ma/ma-maths/1st/topology-final.pdf
6. https://youtu.be/XHKcrs8YaSo?list=PLGr2lFX0u1-__lRhZ5SbOVIZZ5E7aouNu

Title of the Course: Differential Equations		**Semester: II**
Course Code: LPMSCT24	**Contact hours: 5hrs/w**	**Credits: 4**

Course Learning Outcomes:

On completion of the course, the students are able to

- construct convergent power series solutions to ordinary differential equations.
- recognize the solutions of legendre, euler and bessel equations.
- apply ordinary differential equations in other disciplines.

- apply partial derivative equation techniques to predict the behavior of certain phenomena.
- describe real world system using partial differential equations.

Pre Required Knowledge:

- ✓ Basics of differentiation and integration
- ✓ derivative of algebraic functions, logarithmic function, exponcitial function, circular functions
- ✓ definition of hyperbolic functions and its derivatives.

Unit I: Linear equations with variable coefficient

Introduction, Initial value problems for the homogeneous equation, Solutions of the homogeneous equation, The Wronskian and linear independence, Reduction of the order of a homogeneous equation, The non-homogeneous equation, Homogeneous equation with analytic coefficients, The Legendre equation.

Unit II: Linear equations with regular singular points

Introduction, The Euler equation, Second order equations with regular singular points – an example, Second order equations with regular singular points – the general case - The Bessel equation, The Bessel equation (continued).

Unit III: Existence and uniqueness of solutions to First order equations

Introduction, Equations with variables separated, Exact equations, The method of successive approximations, The Lipschitz condition, Convergence of successive approximations, Non-Local existence of solutions, Approximations to and uniqueness of solutions.

Unit IV: Partial differential equations of the First order

Partial differential equation – Origin of first order partial differential equations – Cauchy's problem for first-order equations – Linear equations of first order – Integral surfaces passing through a given curve.

Unit V: Partial differential equations of the First order (continued)

Non-linear partial differential equations of the first order – Cauchy's method of Characteristics – Compatible systems of first order equations – Charpit's method.

Suggested Topics for Group Discussion/ Presentation:

1. The Wronskian and linear independence
2. The Bessel equation
3. Non-Local existence of solutions
4. Cauchy's problem for first-order equations
5. Charpit's method

Suggested Readings:

(i) Text Books:

1. Earl.A.Coddington, An Introduction to ordinary differential equations, Prentice Hall of India, 2003
2. Ian Sneddon, Elements of Partial differential equations, Tata McGraw Hill book Company,1986.

Text Book: 1:

Unit 1: Chapter 3 Section 1 to 8.

Unit 2: Chapter 4 Section 1 to 4 and 7, 8.

Unit 3: Chapter 5 Section 1 to 8.

Text Book: 2:

Unit 4: Chapter 2 Section 2.1 to 2.5

Unit 5: Chapter 2 Section 2.7 to 2.11.

(ii) Reference books:

1. Williams E.Boyce and Richard C.Diprima, Elementary Differential Equations and Boundary value problems, 10th edition, John Wiley and sons, New York,2012.
2. M.D.Raisinghania, Advanced Differential equations, S.Chand& company Limited, New Delhi, 2012.
3. .K.Sankara Rao, Introduction to Partial Differential Equations, Third Edition,PHI Learning New York , 2011.

(iii) Web Resources:

1. http://www.mathinsight.org/ordinary_differential_equation _introduction
2. http://tutorial.math.lamar.edu/classes/DE/DE.aspx
3. http://www.Khanacademy.org/math/differential-equations

Title of the Course: Optimization Techniques **Semester: II**

Course Code: LPMSDS21 **Contact hours: 5hrs/w** **Credit: 3**

Course Learning Outcome:

On completion of the course, the students are able to

- gain skillful in network models.
- recall some basic principles of optimization techniques and solve shortest path problems, Maximal flow problems, CPM and PERT problems.
- analyze transient behavior of Queuing models.
- summarize the classical optimization theory and solve some problems.
- interpret the principle of non-linear problems.
- construct network models and solve problems using algorithms

Pre Required Knowledge:

- ✓ Fundamental concepts of group structure.
- ✓ Basic concepts of logic and & relations.
- ✓ Fundamental knowledge of arithmetic expressions.

Unit I: Network models

Network models-minimal spanning algorithms-shortest route algorithms-Dijkstra's algorithms-Floyds algorithm-maximal flow algorithm.

Unit II: CPM and PERT

CPM and PERT - Network representation critical path(CPM) computations-constructions of the time schedule-determination of floats.

Unit III: Queuing systems

Queuing systems - elements of queuing model - role of exponential distribution - pure birth and death models - Generalized Poisson queuing model – Specialised poisson queues - steady-state measure of performance - single server models - (M/M/1): (GD/∞/∞), (M/M/1):(GD/N/∞), multi server models (M/M/c):(GD/∞/∞).

Unit IV: Classical optimization theory

Classical optimization theory - unconstrained problems-necessary and sufficient conditions - the Newton Raphson method-constrained algorithms-equality constraints – inequality constraints.

Unit V: Non-linear programming

Non-linear programming algorithms - unconstrained algorithms - direct search method - gradient method - constrained algorithms - separable programming - quadratic programming - geometric programming - linear combination method.

Suggested Topics for Group Discussion/ Presentation

1. Finite state machine
2. Arithmetic expressions and identifiers
3. Boolean algebra
4. Minimization problem
5. Matrix encoding techniques

Suggested Readings:

(i) Text Book:

Hamdy A. Taha, Operations Research, An Introduction, Printice – Hall, Seventh Edition, 2005.

Unit I: Chapter 6 sections 6.1; 6.2; 6.3-6.3.1, 6.3.2; 6.4-6.4.1, 6.4.2.

Unit II : Chapter 6 sections 6.6- 6.6.1, 6.6.2, 6.6.3

Unit III : Chapter 17section 17.1 to 17.6.4.

Unit IV : Chapter 20

Unit V: Chapter 21 sections 21.1.1,21.1.2, 21.2.1, 21.2.2, 21.2.3and21.2.5.

(ii)Reference books:

1. B.S. Goel, S.K. Mital, Operations Research, Pragati Prakashan, 1996.
2. Frederick S. Hillier, Gerald J. Lieberman, Introduction to Operations Research, Seventh Edition, The McGraw-Hill Companies, 2003.
3. Kantiswarup, P.K.Gupta and Man Mohan, 2014, Operations Research, Sultan Chand & Sons, New Delhi.
4. Wayne L.Winston, Operations Research Applications and Algorithms, Fourth Edition, Cengage Learning India private Limited, New Delhi, 2010.
5. J.K.Sharma, Operations Research Theory and Applications , Third Edition Macmillan India Limited , Chennai, 2009

(iii) Web Resources:

1. http://www.ifp.illinois.edu/~angelia/ge330fall09_spantree_l16.pdf
2. https://www.youtube.com/watch?v=p05uYEh3ybM
3. https://en.wikipedia.org/wiki/Dijkstra%27s_algorithm
4. https://www.geeksforgeeks.org/floyd-warshall-algorithm-dp-16/
5. https://www.youtube.com/watch?v=3wmsXtSUm8Y
6. https://www.geeksforgeeks.org/difference-between-pert-and-cpm/
7. https://www.youtube.com/watch?v=Us5YtgvfomQ
8. http://www.nou.ac.in/Online%20Resourses/30-8/bba3.pdf
9. https://www.qminder.com/what-is-queuing-solution/
10. https://www.youtube.com/watch?v=YlS3E3aFEq0
11. http://homedir.jct.ac.il/~dreyfuss/OR2/8.Exercise/formulas.pdf
12. http://www.lehigh.edu/~eup2/teaching/ie221/lec12.pdf
13. https://link.springer.com/article/10.1007/BF00939376

14. https://www.youtube.com/watch?v=dPQKltPBLfc&t=324
15. https://www.youtube.com/watch?v=58w2ArUH2_M

Title of the Course: Algorithmic Graph Theory **Semester: II**
Course code: LPMSDS22 **Contact Hours: 5hrs/w** **Credits: 3**

Course Learning Outcomes:

On completion of the course, the students are able to

- acquire the knowledge of Algorithmic Graph Theory
- understand the concepts of Digraphs.
- understand Algorithms and Networks. To develop the proof writing skills.
- recall some basic programming principles and algorithm design techniques
- illustrate some basic graph theoretical algorithms and analyze some common graph theory algorithms.

Pre required knowledge:

- ✓ Basic knowledge of Digraphs.
- ✓ Polya's counting theorem.
- ✓ Knowledge of Algorithms.

Unit I: Digraphs

Introduction - Digraphs and Binary relations, Directed paths and connectedness, Euler digraphs, Trees with directed edges, Fundamental circuits in digraphs, Matrices A, B and C of digraphs, Adjacency Matrices of a digraph, Paired comparisons and tournaments, Acyclic digraphs and decyclization.

Unit II: Enumeration

Types of enumeration, counting labeled trees, counting unlabelled trees, Polya's counting theorem, Graph enumeration with Polya's theorem.

Unit III: Algorithms

Algorithms, Computer representation of a graph, The output, some basic algorithms, "Shortest path algorithms,

Depth-first search on a graph, Isomorphism algorithm, Other graph – theoretic algorithms, performance of graph – theoretic algorithms, Graph – theoretic computer languages.

Unit IV: Network I

Contact networks, Analysis of contact networks, synthesis of contact networks, Sequential switching networks, unit cube and its graph, graphs in coding theory.

Unit V: Network II

Network - Kirchoff's current and voltage laws – loop currents and node voltages - RLC networks with independent sources: Nodal analysis, loop analysis, general lumped, linear fixed networks.

Suggested Topics for Group Discussion/ Presentation:

1. Directed Paths
2. Counting labelled trees
3. Shortest path algorithms
4. Graphs in coding theory
5. Kirchoff's current and voltage laws

Suggested Readings:

(i) Text Book:

Narasingh Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice Hall of India, 2001

Unit - 1 Chapter – 9: Sections: 9.1 to 9.11

Unit - 2 Chapter – 10: Sections: 10.1 to 10.5

Unit - 3 Chapter – 11: Sections: 11.1 to 11.10

Unit - 4 Chapter – 12: Sections: 12.1 to 12.6

Unit - 5 Chapter – 13: Sections: 13.1 to 13.6

(ii) Reference books:

1. Lowell W. Beineke, MartinCharlesGolumbicand Robin J. Wilson, Topics in Agorithmic Graph Theory, Cambridge University Press,2021.

2. Gary Chartrand, and O.R.Ollermann, Applied and algorithmic graph theory, McGraw Hill Education, 1993
3. 3.J.A. Bondy and U.S.R. Murthy, Graph Theory with applications, Macmillan Co., London, 1976.
4. Alan Gibbons, Algorithmic Graph Theory,Cambridge University Press, 1994
5. Martin Charles Golumbic, Algorithmic Graph Theory and Perfect Graphs, second edition, Elsevier Publication, 2004.

(iii)Web Resources:

1. https://www.theschoolrun.com/What-is-a-digraph
2. https://arxiv.org/pdf/1001.0072
3. https://towardsdatascience.com/graph-theory-basics-88a89863e3c1

Title of the Course: Combinatorial Mathematics **Semester: II**
Course Code: LPMSAE21 Contact hours: 2hrs/w **Credits: 2**

Course Learning Outcomes:

On completion of the course, the students are able to

- acquire the knowledge of Combinatorial Mathematics.
- understand the concepts of permutations and Combinations, Generating functions, Recurrence relations,
- study the principle of inclusion and exclusion
- understand the concept of distinct objects in non distinct cells
- analyze the concepts of derangements

Pre Required Knowledge:

- ✓ Fundamental knowledge of permutations and combinations
- ✓ Basic concepts of mathematical induction
- ✓ Basic concepts of recurrence relations**.**

Unit I: Permutations and Combinations

Introduction – The rules of sum and product. Permutations – Combinations – Distributions of distinct objects – Distributions of Non-distinct objects.

Unit II: Generating functions I

Introduction – Generating functions for combinations – Enumerators for permutations.

Unit III: Generating functions II

Distributions of distinct objects into non-distinct cells – Partitions of integers – The Ferrer's Graph – Elementary relations

Unit IV: Recurrence relations

Introduction – Linear recurrence relations with constant coefficients – Solution by the technique of generating functions – A special class of non–linear difference equations.

Unit V: The principle of inclusion and exclusion

Introduction – The principle of inclusion and exclusion – the general formula – Derangements

Suggested Topics for Group Discussion/ Presentation

1. Distributions of Non-distinct objects.
2. Partitions of integers
3. Linear recurrence relations
4. inclusion and exclusion
5. Derangements

Suggested Readings:

(i) Text Book:

C.Y.Liu, Introduction to combinational mathematics, McGraw-Hill, 1968

Chapter 1 (Sections: 1.1 to 1.6)

Chapter 2 (Sections 2.1 to 2.3)

Chapter 3 (Sections 2.4 to 2.7)

Chapter 4 (Sections 3.1 to 3.4)

Chapter 5 (Sections 4.1 to 4.4)

(ii) Reference books:

1. Anderson and Ian, A First Course in Combinatorial Mathematics, Clarenden Press, 1975.
2. S.Santha, Discrete Mathematics with Combinatorics and Graph Theory, Cangage Learning 2012

3. Alan Tucker, Applied Combinatorics, Wiley, 2012

(iii)Web Resources:

1. https://math.stackexchage.com
2. https://www.springer.com
3. https://www.quora.com
4. https://www.journalselsevier
5. https://.britannica.com

Title of the Course: Fuzzy Set Theory and its Applications Semester: II

Course Code: LPMSSC21 Contact Hours: 5hrs/w Credits:2

Course Learning Outcomes:

On completion of the course, the students are able to

- compare fuzzy sets and crisp sets and define fuzzy logics
- find union, intersection and complement of fuzzy sets and prove results on the same
- discuss the properties of fuzzy relations and perform various compositions of fuzzy relations
- construct fuzzy graphs and list the special fuzzy relations
- apply fuzzy set theory in real life situations

Pre Required Knowledge:

- ✓ To acquire the knowledge of Automata Theory and Formal Language.
- ✓ To understand the concepts of Finite Automata.
- ✓ To understand the concepts of Regular Expression.

Unit I: Crisp Sets and Fuzzy Sets

Crisp Sets: An Overview – The Notion of Fuzzy Sets – Basic Concepts of Fuzzy Sets

Unit II: Operations on Fuzzy Sets

General Discussion – Fuzzy Complement – Fuzzy Union – Fuzzy Intersection – Combinations of Operations – General Aggregation Operations.

Unit III: Fuzzy Relations

Crisp and Fuzzy Relations – Binary Relations – Binary Relations on a Single Set – Equivalence and Similarity Relations – Compatibility or Tolerance Relations.

Unit IV: Fuzzy Measures

General Discussion – Belief and Plausibility Measures

Unit V: Uncertainty and Information

Types of Uncertainty – Measures of Fuzziness – Classical Measures of Uncertainty

Suggested Topics for Group Discussion/ Presentations:

1. Crisp Set
2. Combinations of Operations
3. Fuzzy relation on fuzzy set
4. Plausibility Measures
5. Measures of Fuzziness

Suggested Readings:

(i)Text Book:

George J. Klir& Tina A. Folger, (2008). Fuzzy sets, Uncertainty and Information, New Delhi: Prentice Hall of India Pvt. Ltd. Print.

Unit 1 : Chapter 1.1 to 1.4

Unit 2 : Chapter 2.1 to 2.6

Unit 3 : Chapter 3.1 to 3.5

Unit 4 : Chapter 4.1, 4.2

Unit 5 : Chapter 5.1 to 5.3

(ii)Reference books:

1. Zimmermann H.J., (2006). Fuzzy set Theory and its Applications, (4th ed.), New Delhi: Springer Publication. Print.
2. Meenakshi A. R., (2008). Fuzzy Matrix Theory and Applications, Chennai: MJP Publishers. Print.

3. George J. Klir& Bo Yuan, (1995). Fuzzy sets and Fuzzy Logic Theory and Applications, New Delhi: Prentice Hall of ndia Pvt. Ltd. Print.

(iii)Web Resources:

1. Atta KodallaVantillu. (2019, April 1). FL – Classical Relations – Operations and Properties [Video file]. Retrieved from https://youtu.be/DzyCBHPTyIk. CC BY license.
2. Mohamed Salih Mukthar. (2020, May 6). Fuzzy Sets – Basic concepts [Video file]. Retrieved from https://youtu.be/ RrseZK1obA CC BY license.
3. Muhammad Adam Fahmil 'Ilmi. (2018, March 11). Fuzzy Logic Application in Real Life–Robotics [Video file]. Retrieved from https://youtu.be/DW1eegaH6Ys CC BY license.
4. Welcome Engineers. (2019, September 25). Introduction to Graph in Tamil [Video file]. Retrieved from https://youtu.be/iH5PYVhX-KsCC BY license.

Title of the Course: Applications of Graph Theory **Semester: II**
Course Code: LPMSSC22 Contact Hours: 5hrs/w **Credit: 2**

Course Learning Outcomes:

On completion of the course, the students are able to

- define different dominating sets and prove the related results.
- apply the algorithms to find the required results in graphs and digraphs.
- construct the flows in networks and prove theorems.
- determine edge connectivity and prove related results.
- apply the different concepts in digraphs, matchings, planarity, colorability and domination to solve problems.

Pre Required Knowledge:

- ✓ Basics of Graphs and Matrices.
- ✓ Connectedness in Graph Theory.
- ✓ Fundamentals of domination

Unit I: DOMINATION

The Domination Number of a Graph – Exploration: Stratification – Exploration : Light outs – Excursion – And still it Grows More Colorful

Unit II: ALGORITHMS

Tree Search Algorithms: tree search – breadth – first search and shortest paths – depth-first search finding the cut vertices and blocks of a graph – branching search – finding shortest paths in weighted digraphs–directed depth-first search–finding the strong components of a digraph

Unit III: **FLOWSINNETWORKS**

Transportation networks–max-flowmin-cuttheorem–fourcolortheorem–Kempechains –Kempe's erroneous proof–reducibility–unavoidability.

Unit IV: GOMORY-HUTREES

Determining edge connectivity – chordal graphs – clique cuts – simplical vertices – tree representation

Unit V: APPLICATIONS

Wine bottle problems–instant insanity–embedding graphs in Graphs –local coloring–lights out

Suggested Topics for Group Discussion/ Presentations:

1. Domination Sets
2. finding shortest paths in weighted digraphs Binomial distribution
3. Transportation networks
4. chordal graphs
5. Wine bottle problems

(i)Text Books:

1. Gary Chartrand & Ping Zhang, (2006). Introduction to Graph Theory, New Delhi: TataMcGraw – Hill Publishing Company Ltd. Print.

   Unit 1 : Chapter 13

2. Bondy & Murthy, (2008). Graph Theory, USA: Springer International PvtLtd. Print.

   Unit 2: Chapter:6(6.1,6.3),

Unit 3: Ch7(7.1,7.2),

Unit 4: Ch9(9.6,9.7),

3. KulliV.R., (2010). Theory of domination in graphs, Mysore: Vishwa International Publications, Print.

   Unit 5: Chapter:2(2.1–2.4),3(3.1–3.4,3.9).

(ii) Reference books:

1. Teresa W.Haynes, Stephen Hedetniemi and Peter Slater, (1998). Fundamentals of domination in graphs, New York: Marcel Dekker, Inc., Print.
2. Temperley H.N.V., Graph Theory and Applications, Halstead Press, 1981.
3. Wilson R.J and L.W. Beineke, Applications of Graph Theory, Academic Press, 1979.

(iii) Web Resources:

1. Backtoback SWE. (2019, October 27). Network Flows: Max-FlowMin-Cut Theorem (& Ford-Fulkerson Algorithm) [Video file]. Retrieved from https://youtu.be/oHy3ddI9X3o.CCBYlicense.
2. Graph Theory for Educators (2016, April17). Intro Surfaces–27 [Video file]. Retrieved from https://youtu.be/2r_NTS8bHAw.CCBYlicense.
3. Go Gate IIT. (2013, February 17). Depth First Search Algorithm [Videofile]. Retrieved from https://youtu.be/iaBEKo5sM7w.CCBYlicense.
4. Mathat Andrews. (2020, April2). Graph Theory 8: Four Color Theorem (Kempe's Proof), [Video file]. Retrieved from https://youtu.be/adZZv4eEPs8.CCBYLicense.
5. Michel Bierlaire. (2019, June13). Exact methods: Gomorycuts [Video file]. Retrieved from https://youtu.be/VdXHGNDnjjo.CCBYlicense.
6. Mycodeschool. (2014, February 24). Binary tree traversal-breadth-first and depth-first strategies [Video file]. Retrieved from https://youtu.be/9RHO6jU--GU.CCBYlicense.

7. PBS Infinite Serier (2018, April26) Instant Insanity Puzzle Infinite Series [Video file]. Retrieved from https://youtu.be/Lw1pF47N-0Q.CCBYlicense.
8. Sunilkumar Hosamani. (2020, April23). Examples for Domination number [Video file]. Retrieved from https://youtu.be/7NuM5unQYt4.CCBY license.
9. Sunilkumar Hosamani. (2020, May 4). Bounds for Domination Number of a Graph [Video file]. Retrieved from https://youtu.be/R388D83JC_k.CCBYlicense.
10. Scholartica Channel. (2015, September 4). Connected Dominating Sets and its Applications: Part1[Video file]. Retrieved from https://youtu.be/HOgOQ9az_jo. CCBYlicense.
11. Turing Machines. (2019, Jun 22). Depth First Search (DFS) on Directed graphs and Cyclic Graphs [Video file]. Retrieved from https://youtu.be/c7sUDqgrCaY.CCBYlicense.
12. Wrath of Math. (2020, June 26). Edge Cuts and Edge Connectivity |Graph Theory. [Video file] Retrieved from https://youtu.be/grAiuM6tZuA.CCBYlicense.

Title of the Course: Field Theory and Lattice Theory **Semester: III**
Course Code: LPMSCT31 **Contact hours: 6hrs/w** **Credit: 5**

Course Learning Outcome:

On completion of the course, the students are able to

- understanding the basic concepts of algebraic extensions.
- apply the roots of Polynomials and Isomorphism.
- gain knowledge of the polynomials and splitting fields.
- learn and explain the Solvability by Radicals.
- Under stand Boolean algebra and Boolean Ring**.**

Pre Required Knowledge:

- ✓ The basic knowledge of Algebraic equation.
- ✓ Fundamental of fields and group.
- ✓ Learn the group and Ring.

Unit I: Extensions Fields

Extensions Fields-Finite Extensions –Algebraic Extensions -The transcendence of e.

Unit II: Splitting fields

Roots of Polynomials, Isomorphism of Polynomials-Splitting Fields Construction with straight edge and Compass-More about roots.

Unit III: Galois theory and applications

The Elements of Galois theory-Simple Extensions – Fixed Fields –Symmetric rational functions – Normal Extensions – Galois group – Fundamental theorem of Galois theory.

Unit IV: Solvability by Radicals

Solvable groups – The commutor sub group - Solvability by Radicals **-** Galois Group over the Rational's, Finite Fields-Wedderburn's theorem on finite division rings.

Unit V:Lattices theory and Boolean Algebra

Lattices – Simple properties and examples – Modular Lattice, Distributive Lattice - Isomorphism of Lattice. Boolean Algebra – Equivalence of Boolean algebra and Boolean Ring –Stone's theorem.

Suggested Topics for Group Discussion/ Presentation:

1. Algebraic Extension
2. Splitting field polynomials
3. Fundamental theorem of Galois theory
4. Solvable groups
5. Stone's theorem

Suggested Readings:

(i) Text Book:s

1. I.N. Herstein,Topics in Algebra, John Wiley and sons, Second Edition U.S.A.1999.
2. Nathan Jocobson, Basic Algebra, Volume II, Hindustan publishing Corporation, NewYork 1984.

Book 1

Unit I: Chapter : 5 Sections 5.1 and 5.2,

Unit II: Chapter : 5 Sections 5.3 and 5.5

Unit III : Chapter : 5 Section 5.6 and 5.7

Unit IV: Chapter : 5 Section 5.8, Chapter : 7 section 7.1,7.2

Book 2

Unit V: Chapter 8 Sections 8.1 to 8.5

ii) Reference books:

1. Surjeet Singh, Qazizameeruddin, Modern Algebra, 7th Revised edition, Vikas Publications Pvt. Ltd – New Delhi 2005.
2. Thomas W. Hungerford, Algebra, Springer, 1974.
3. Garret Birkhoff and Thomas C. Bartee, Modern Applied Algebra,CBS Publishers and Distributors, 1987.

(iii)Web Resources:

1. http://abstract.ups.edu/aata/section-extension-fields.html
2. https://faculty.math.illinois.edu/~eid1/sp.pdf
3. https://www.javatpoint.com/discrete-mathematics-boolean-algebra

---

Title of the Course: Functional Analysis **Semester: III**

Course Code: LPMSCT32 **Contact hours: 6hrs/w** **Credit: 4**

Course Learning Outcomes:

On completion of the course, the students are able to

- understanding basic concepts of normed and continuity.
- understand the concepts of normed linear space.
- apply the Banach spaces and Hilbert spaces.
- learn the duals and transposes.
- gain the knowledge of inner products.

Pre Required Knowledge:

- ✓ Learn the normed spaces.
- ✓ The basic knowledge of bounded and uniform.
- ✓ Fundamental of Inner Product Spaces.

Unit I: Normed spaces

Fundamentals of Normed spaces - Normed spaces - Continuity of linear maps – Bounded linear maps.

Unit II: Banach spaces

Hahn-Banach theorems - Banach spaces (except Banach limits).

Unit III: Bounded Linear Maps

Bounded Linear Maps on Banach spaces- Uniform Boundedness principle - Closed Graph theorem – Open Mapping theorem – Spectrum of a bounded operator.

Unit IV: Duals spaces

Spaces of Bounded Linear Functional - Duals and Transposes – Duals of $L^P([a,b])$ and $C([a,b])$

Unit V: Geometry of Hilbert Spaces

Inner product Spaces – Ortho Normal Sets – Approximation and Optimization

Suggested Topics for Group Discussion/ Presentation:

1. Fundamentals of Normed spaces
2. Hahn-Banach theorems
3. Uniform Boundedness principle
4. Duals of LP([a,b]) and C(a,b])
5. Geometry of Hilbert Spaces.

Suggested Readings:

(i) Text Book:

Balmohan Vishnu Limaye, Functional Analysis, Revised Third Edition,New age International, New Delhi 2017.

Unit I: (Chapter II : Sections 5 and 6)

Unit II: (Chapter II : Sections 7.1 to 7.8 , 8.1 to 8.4)

Unit III: (Chapter III : Sections 9.1 to 9.3, 10.1 to 10.6, 12.1 to 12.6,12.8)

Unit IV: (Chapter IV : Sections 13.1 to 13.10,14.1 to 14.3)

Unit V: (Chapter VI : Sections 21,22,23,23.1,23.2,23.3)

(ii) Reference books:

1. G.F. Simmons, Introduction to Topology and Modern analysis, Tata McGraw-Hill, New Delhi 1963.
2. S. Ponnusamy, Foundations of Functional Analysis, Narosa Publishing House, New York 2002.
3. S. Kesavan, Functional Analysis, TRIM Series, Hindustan Book Agency, New Delhi, 2009.
4. Rajendra Bhatia, Lectures on Functional Analysis, TRIM Series Hindustan Book Agency, New Delhi, 2009.

(iii) Web Resources:

1. https://wiki.math.ntnu.no/linearmethods/boundedlinearmappings
2. https://faculty.etsu.edu/gardnerr/Func/notes/6-1.pdf
3. https://mathworld.wolfram.com/InnerProduct.html

Title of the Course: Statistics – I **Semester: III**
Course Code: LPMSCT33 **Contact hours: 6hrs/w** **Credit: 4**

Course Learning Outcomes:

On completion of the course, the students are able to

- illustrate the Concept of sample space, the probability and conditional probability of events.
- use Baye's rule, the concepts of discrete and continuous random variable, discrete and continuous probability, chebyshevs theorem.
- understand the probability distribution function and apply theorems concerning the distribution function and moment – generating function.
- develop the properties of bivariate probability distributions.
- apply the concept of Limiting moment generating Function.

Pre Required Knowledge:

- ✓ The basic concepts of mean, median and mode.
- ✓ Basic knowledge of continuous and discrete types.

- ✓ Fundamental of some distributions.

Unit I: Probability

The Probability Set Function – Conditional probability and Independence - Random variables of the Discrete type – Random variables of the Continuous type Properties of Distribution Function – Expectation of Random Variable – Some Special Expectations — Chebyshev's inequality.

Unit II: Multivariate Distributions

Distribution 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 Distribution – The Bivariate Normal Distribution.

Unit IV: Distributions of Function of Random variable

Sampling Theory – Transforms of Variables of the continuous Type – The Beta, t and F Distributions – Extensions of the Change of variable Technique – The Moment Generating Function Technique - The distributions of X and $nS^2/^2$- Expectations of Functions of Random Variable.

Unit V: Limiting Distributions

Convergence in Distribution – Convergence in Probability – Limiting moment generating Function – The Central Limit Theorem – Some Theorems on Limiting Distributions.

Suggested Topics for Group Discussion/ Presentation

1. Discrete random variables and Continuous random variables.
2. Some Special Expectations.
3. The correlation coefficient.
4. The Gamma, Chi-Square and Beta Distributions.
5. Tests based on t, F- Distributions.

Suggested Readings:

(i)Text Book:

Robert V. Hogg and Allen T. Craig, Introduction to Mathematical Statistics,

Fifth Edition, Pearson Education, 2005.

Unit I : Chapter 1 : Sections 1.3 to 1.10

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 4.9

Unit V : Chapter 5 : Sections 5.1 to 5.5

(ii) Reference books:

1. A. M. Mood, F. A. Gray Bill and D. C. Boes, Introduction to the Theory of Statistics, Tata McGraw-Hill Publication, Third Edition, 2005.
2. 2.John E. Freund, Mathematical Statistics, Prentice-Hall of India, Fifth Edition, 1992.
3. 3.Bhat B.R, An Introductory of Modern probability Theory , Third Edition (Reprint), New Age International PVT, New Delhi(2009).
4. Rohatgi V.K. and Saleh, An Introduction to Probability and Statistics , AKME, Third Edition , John Wiley& Sons , NY(2015).
5. Mukhopadhyay P, Mathematical Statistics, Third Edition,Books and Allied (P) LMT, Kolkata(2006).

(iii) Web Resources:

1. https://www.cuemath.com/data/probability/
2. http://mgmt.iisc.ac.in/CM/LectureNotes/random_variables.pdf
3. https://en.wikipedia.org/wiki/List_of_probability_distributions
4. https://faculty.math.illinois.edu/~r-ash/Stat/StatLec1-5.pdf
5. http://sdeuoc.ac.in/sites/default/files/sde_videos/Probability%20distribution%20and%20Sampling%20theory.pdf

6. https://edoras.sdsu.edu/~babailey/reut09/lecture13.pdf

Title of the Course: Measure Theory **Semester: III**

Course Code: LPMSCT34 **Contact Hours: 5hrs/w** **Credit : 4**

Course Learning Outcomes:

On completion of the course, the students are able to

- acquire the knowledge of Measure Theory.
- understand the concepts of measure, measurable sets.
- acquire the knowledge of measurable functions and their properties**.**
- acquire the knowledge of L^P spaces and various inequalities
- understand the concept of differentiation and integration in Lebesgue set.

Pre Required Knowledge:

- ✓ Fundamental definition of Interval.
- ✓ Basic knowledge of infimum and supremum.
- ✓ Basic definition of derivative, continuous, etc.

Unit I: Measure on the Real line

Lebesgue outer measure – Measurable sets – Regularity- Measurable functions.

Unit II: Measure on the Real line(continued) and integration of Functions of a Real variable

Borel and Lebesgue measurability- Integration of non-negative functions – The general integral.

Unit III: integration of Functions of a Real variable(continued) and Differentiation

Integration of series- Riemann and Lebesgue integrals – The four derivatives.

Unit IV: Differentiation(continued)

Continuous non – differentiable functions- Functions of bounded variations – Lebesgue differentiation theorem- Differentiation and integration – The Lebesgue set.

Unit V: Inequalities and the L^p spaces

Measure space – The L^p spaces – convex functions – Jensen's inequality – The inequalities of Holder and Minkowski – Completeness of $L^p(\mu)$.

Suggested Topics for Group Discussion/ Presentation

1. Lebesgue outer measure
2. The general integral.
3. Riemann and Lebesgue integrals
4. The Lebesgue set
5. Inequalities on measure space

Suggested Readings:

i) Text Book:

G. de Bara, Measure theory and Integration, Wiley Eastern Ltd., Second Edition 1991.

Unit I : Chapter 2: Sections 2.1 to 2.4

Unit II : Chapter 2 : Sections 2.5 Chapter 3: Sections 3.1,3.2.

Unit III : Chapter 3 : Sections 3.3, 3.4, Chapter 4: Section 4.1.

Unit IV : Chapter 4 : Sections 4.2 to 4.6.

Unit V : Chapter 5: Section 5.5., Chapter 6: Sections 6.1 to 6.5.

ii) Reference books:

1. J. L. Doob, Measure Theory, Springer International Edition, 2010.
2. Inder K. Rana, An introduction to measure and integration, Narosa Publishing house, Second Edition, 2005.
3. Sergei ovchinnikov, Measure Integral Derivative, Springer, Newyork.

(iii)Web Resources:

1. https://bcmullins.github.io
2. https://nptel.ac.in
3. https://math.stackexchage.com
4. https://library.oapen.org
5. https://gauravtiwari.org

Title of the Course: Mathematics for CSIR –UGC NET/SET Semester: III
Course Code: LPMSAE31 Contact hours: 2hrs/w Credits: 2

Course Learning Outcomes:

On completion of the course, the students are able to

- Overcome the difficulties in the competitive examinations
- do research in leading institutions
- qualify for the teaching posts in the institutions
- enrich analytical thinking in higher mathematics
- develop various mathematical skills to solve the problems

Pre-required Knowledge:

- ✓ Fundamentals of Analysis
- ✓ Basic concepts of Algebra
- ✓ Fundamental concepts in Geometry

Unit I: Analysis I

Elementary set theory, finite, countable and uncountable sets – Real number system as a complete ordered field - Archimedean property - supremum, infimum - Sequences and series - convergence, lim sup and liminf– Bolzano Weierstrass theorem – Heine Borel theorem - Continuity, uniform continuity - different liability, mean value theorem – Sequences and series of functions- uniform convergence.

Unit II: Analysis II

Riemann sums and Riemann integral, Improper Integrals – Monotonic functions, types of discontinuity, functions of bounded variation – Lebesgue measure - Lebesgue integral – Functions of several variables – directional derivative – partial derivative – derivative as a linear transformation – inverse and implicit function theorems – Metric spaces - compactness, connectedness – Normed linear Spaces – Spaces of continuous functions as examples.

Unit III: Algebra

Permutations, combinations – pigeon – hole principle – inclusion – exclusion principle – derangements –

Fundamental theorem of arithmetic – divisibilitying – congruences – Chinese Remainder Theorem - Euler's Ø-function – primitive roots - Groups, subgroups, normal subgroups, quotient groups - homomorphisms, cyclic groups, permutation groups - Cayley's theorem, class equations –Sylow theorems - Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain, Euclidean domain.- Fields, finite fields, field extensions, Galois Theory.

Unit IV: Linear Algebra

Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations – Algebra of matrices, rank and determinant of matrices, linear equations –Eigen values and eigen vectors – Cayley – Hamilton theorem – Matrix representation of linear transformations – Change of basis, canonical forms, diagonal forms, triangular forms, Jordan forms – Inner product spaces, orthonormal basis – Quadratic forms, reduction and classification of quadratic forms.

Unit V: Complex Analysis

Algebra of complex numbers, the complex plane, polynomials, power series, transcendental functions such as exponential, trigonometric and hyperbolic functions – Analytic functions, Cauchy-Riemann equations – Contour integral, Cauchy's theorem, Cauchy's integral formula, - Liouville's theorem, Maximum modulus principle, Schwarzlemma, Open mapping theorem -Taylorseries, Laurent series, calculus of residues. Conformal mappings, Mobius transformations.

Suggested Readings:

(i)Text Book:

Alok Kumar, Upkar's CSIR – UGC NET/JRF/SET Mathematical Sciences, Upkar Prakashan,2010

(ii) Reference books:

1. I.N. Herstein, Topics in Algebra, Second Edition, John Wiley and sons, 1999

2. Joseph A Gallian, Contemporary Abstract Algebra, Narosa Publication, New Delhi, 1999.
3. Vijay K Khanna and S.K. Bhambri, A course in Abstract Algebra, Vikas Publishing House Pvt. Ltd., New Delhi, 2015.
4. Walter Rudin, Principles of Mathematical Analysis, McGraw Hill Education (India) Edition, 2013.
5. H.L.Royden, Real Analysis, Macmillan Publishing Company,1987
6. S.C. Malik, Principles of Real Analysis, New Age International Publishers,1996
7. James R.Munkres, Topology, (Second Edition) Pearson Prentice – Hall of India Private Ltd, 2007.
8. G.F.Simmons, Introduction to Topology and Modern Analysis, Tata Mcgraw-Hill Publishing Company Ltd., New Delhi, 5th Reprint, 2006.
9. Lars V.Ahlfors, Complex Analysis, Third Edition, McGraw Hill Education (India) Private Limited, New Delhi, 2013
10. Ponnusamy, S., Foundations of Complex Analysis, Narosa Publishing House Private Limited, New Delhi, 2013.

(iii)Web Resources:

1. https://pkalika.in/handwritten-study-materials/
2. https://scoop.eduncle.com/csir-net-mathematical-sciences
3. https://byjusexamprep.com/csir-net-mathematical-science-books-i

---

Title of the Course: Graphs and Matrices **Semester: III**
Course Code: LPMSSC31 **Contact hours: 2hrs/w** **Credits: 2**

Course Learning Outcomes:

On completion of the course, the students are able to

- understand the concepts of Matrices.
- relate connectivity concepts in graphs.
- basic Concepts of eigen values of symmetric matrices
- analyze the bounds and determinants

- develop and understand Laplacian Matrix

Pre required knowledge:

- ✓ Connectedness in Graph Theory.
- ✓ Graphs and Matrices.
- ✓ Path and Trees.

Unit I: Incidence Matrix

Rank – Minors – Path Matrix – Integer generalized inverse – Moore_ Penrose inverse - 0-1 Incidence Matrix – Matchings in bipartite graphs.

Unit II: Adjacency Matrix

Eigen values of some graphs – determinant – Bounds – Energy of a graph – Ant adjacency matrix of a directed graph – Nonsingular trees

Unit III: Laplacian Matrix

Basic Properties – Computing laplacian eigen values – Matrix tree theorem – Bounds for Laplacian spectral radius – Edge Laplacian of a tree

Unit IV: Cycles and Cuts

Fundamental cycles and fundamental cuts – Fundamental matrices - Minors.

Unit V: Regular Graphs

Perron-Frobenius theory – Adjacency algebra of a regular graph – Complement and line graph of a regular graph – Strongly Regular graphs and Friendship theorem – Graphs with maximum energy

Suggested Topics for Group Discussion/ Presentation:

1. Path matrix
2. Bounds
3. Matrix tree theorem
4. Minors
5. Line graph and regular graph

Suggested Readings:

(i) Text Book:

R.B.Bapat, Graphs and Matrices , Hindustan Book Agency 2010

Unit I: Sections 2.1 to 2.7

Unit I: Sections 3.1 to 3.6

Unit III: Sections 4.1 to 4.5

Unit IV: Sections 5.1 to 5.3

Unit V: Sections 6.1 to 6.5

(ii) Reference books:

1. D.B West, Introduction to Graph Theory, 2nd edition, Prentice Hall (2000)
2. R.A.Horn and C.R. Johnson, Matrix Analysis, Cambridge University Press, Cambridge, 1985.
3. R. Balakrishnan and K. Ranganathan, Text Book: of Graph Theory, Springer, 2000.
4. Harary F, Graph Theory, Addison- Wesley, Reading Mass, 1969.
5. D.B West, Introduction to graph theory, Prentice Hall of India, 2001.

(iii)Web Resources:

1. https://mathworld.wolfram.com/EulerianGraph.html
2. https://nrich.maths.org/6291
3. https://mathworld.wolfram.com/Four-ColorTheorem.html

Title of the Course: Graph theory and Combinatorics **Semester: III**
Course Code: LPMSSC32 **Contact hours: 2hrs/w** **Credits: 2**

Course Learning Outcomes:

On completion of the course, the students are able to

- understand the concepts of graphs
- relate connectivity concepts in the eulerian graphs and bipartite graphs
- understand the concepts of Adjacency matrix and incidence matrix
- analyze and Apply concepts of trees and spanning trees
- develop the concepts of mobius functions

Pre required knowledge:

- ✓ Connectedness in Graph Theory.
- ✓ Graphs and Matrices.
- ✓ Trees in Graphs.

Unit I: Recurrence Relations

Binomial Coefficients – Derangements – Involutions – Fibonacci numbers – Catalan numbers – Bell Numbers.

Unit II: The Principle of Inclusion and Exclusion

The Main theorem – Derangements revisited – Counting Surjective maps – Stirling Numbers of the first kind – Stirling numbers of the second kind

Unit III: Matrices and Graphs

Adjacency and Incidence matrices – graph isomorphism – Bipartite Graphs and Matrices – Diameter and Eigen values

Unit IV: Trees

Forests, Trees and Leaves – Counting labeled trees – Spanning Subgraphs – Minimum spanning trees and Kruskal's algorithm

Unit V: Mobius Inversion

Posets and Mobius functions – Lattices – The classical mobius functions – the lattice of partitions

Suggested Topics for Group Discussion/ Presentation:

1. Fibonacci Numbers
2. Stirling Numbers
3. Graph isomorphism
4. Spanning subgraphs
5. Posets and Mobius Functions

Suggested Readings:

(i)Text Book:

Sebastian M. Cioaba and M.RamMurty, A First Course in Graph Theory and Combinatorics, Hindustan Book agency 2009

Unit I: Sections 2.1 to 2.6

Unit I: Sections 3.1 to 3.5

Unit III: Sections 4.1 to 4.4

Unit IV: Sections 5.1 to 5.4

Unit V: Sections 6.1 to 6.4

(ii) Reference books:

1. D.B West, Introduction to Graph Theory, 2nd edition, Prentice Hall (2000)
2. R.A.Horn and C.R. Johnson, Matrix Analysis, Cambridge University Press, Cambridge, 1985
3. R. Balakrishnan and K. Ranganathan, Text Book: of Graph Theory, Springer, 2000.
4. Harary F, Graph Theory, Addison- Wesley, Reading Mass, 1969.

D. B West, Introduction to graph theory, Prentice Hall of India, 2001.

(iii) Web Resources:

1. https://mathworld.wolfram.com/EulerianGraph.html
2. https://nrich.maths.org/6291
3. https://mathworld.wolfram.com/Four-ColorTheorem.html

DEPARTMENT OF ENGLISH - PG-CBCS -LOCF

Title of the Course: English for Career Development (NME)		**Semester: III**
Course code: LPENNM31	**Contact hours: 5hrs/w**	**Credits: 4**

Course Learning Outcomes:

On completion of the course, the students are able to

- have the comprehensive understanding of the language ability required in the competitive examination
- effectively use the vocabulary for the fluent and accurate communication
- exercise their grammatical competence in their communications
- confidently meet the job interview requirements

- practise the proficient language skills in all Professional and social interactions

Pre-required knowledge:

- Use of Basic Grammar for Job
- Communicative English for Career
- Writing Skills for Job Purposes

Unit I

Situational Grammar, Tenses, Voices, Prepositions, Articles

Unit II

Sentence Completion

One word Substitution

Homonyms

Phrasal Verbs

Unit III

Reading Comprehension

Analogy

Jumbled Sentence

Errors and How to avoid them

Unit IV

Job Application and Preparing a CV

Expansion of Idea

Report Writing

Essay Writing

Unit V

Interview

Group Discussion

Tips for taking Exam

Suggested Topics for presentation:

- Application process for various jobs
- Providing strategies for identifying the jobs
- Preparing resume for professional jobs
- Writing a clear and concise formal letter

- Developing interview skills

Suggested Readings:

i)Text Book:

Bhatnagar,R.P.*English for Competitive Examinations,*Madras: Laxmi Publication, 2009.

ii) Reference Books:

1. Sharma,Manish.ITI*Employability Skills*.Neelkand publishers,2016.
2. Dixit,Shilpi.*EmployabilitySkills.*BFC Publications,2021.
3. Dhanavel,S.P.*English and Soft Skills.*Orient Blackswan,2011.

iii) Web Source:

1. https://www.coursera.org/learn/careerdevelopment
2. https://www.my.mooc.com/en/mooc/english-for-careerdevelopment
3. https://www.naukri.com/learning/english-for-careerdevelopmentcourse-couri202

DEPARTMENT OF HISTORY – PG - CBCS – LOCF

Course Title : Indian History for Competitive Exams(NME)		**Semester: III**
Course code: LPHSNM31	**Contact Hours: 5**	**Credits: 4**

Course Learning Outcomes:

On completion of this course, the students are able to

- understand the Indus Valley Civilisation.
- explain the administration of Mughals.
- analyse the causes and result of 1857 Mutiny.
- describe the salient features of Constitution of India.
- asses the current events in India and abroad.

Pre- required knowledge:

- Topics of competitive exams.
- Need of General Knowledge.
- Importance of Competitive exams.

Unit I : Ancient Indian History

Sources, - Indus Valley Civilization- Vedic Period - Mauryan Dynasty Buddhism and Jainism- Guptas.

Unite II: Medieval Indian History

Advent of Islam- Establishment of Delhi Sultanate – Mughals and Marathas- Advent of Europeans-Expansion and consolidation of British Rule- Social Reforms-Religious Movements.

Unite III: Indian National Movement

1857 Revolt - Indian National Congress -– Gandhian Era – Role of Tamil Nadu in Freedom Struggle.

Unit IV: Indian Polity

Constitution of India-Preamble- Salient Features - Fundamental Rights and Duties - Panjayat Raj - Center and State Relation- Emergency Provisions- Election Commission- Amendments.

Unit V: Current Events

Profile of States - Defense - National Security and Terrorism, NGO - Eminent Persons and Places- Sports - Books and Authors-Cultural Panorama – Historical Events in India – Covid 19 .

Suggested topics for group discussion and presentation:

- Mauriyan Administration.
- Establishment of Delhi Sultanate.
- Indian National Movement.
- Emergency Provisions.
- Covid 19

Suggested Readings:

Text Books:

1. Ishwari Prasad, History of Medieval India, The Indian Press Ltd., Calcutta, 2006.
2. BipinCandra, History of Modern India, Orient Blackswan Publication, Hydrabad, 2009.

Reference Books:

1. NilakandaSastri, K. A. History of South India, Oxford Publication, Calcutta, 1982.
2. Basham, A.L. Wonder that was India, Rupa and Co Publisher, Delhi, 1967.
3. Bipan Chandra, Modern India, NCERT, New Delhi, 2005.
4. India and the contemporary World- I and II, NCERT, New Delhi.2000
5. Indian History, Part I,II, and III, NCERT, New Delhi,2007.

Web Sources:

www.clearIAS.com

www.jagranJosh.com

www.UPSC.gov.in

DEPARTMENT OF ECONOMICS – PG – LOCF

Title of the Course: Economics for Competitive Examinations (NME)		**Semester: III**
Course Code: LPECNM31	**Contact Hours: 5hrs/w**	**Credits: 4**

Course Learning Outcomes

On completion of the course, the students are able to

Grasp the measures of Economic development and role of NITI Aayog

Acquire the Skill of analysing the Government policies on poverty and population growth.

Evaluate India's trade policy and gain knowledge on IMF, IBRD and ADB.

Analyse the working of Indian Money Market.

Understand the issues in the Indian Federal system and competently appear for Competitive examinations.

Pre- required Knowledge

Economic growth, Economic development and Economic Planning.

Absolute Poverty Vs Relative Poverty.

Internal trade Vs International trade.

Indian Financial Market:Meaning and Structure.

Direct tax, Indirect tax and Non-tax Revenue.

Unit I: Economic Development and Planning

National Income – Various Committees on National Income estimation – Measures of Economic Development(PQLI, HDI, HPI and GDI) – National Income as a measure of welfare – Green Revolution and agriculture development- History of Economic Planning in India – Planning Commission Vs NITI Aayog – India's role in BRICS.

Unit II: Population and Poverty

Population growth in India – Demographic features of India - India's Population Policy – Report of Lakdawala, Tendulkar and Rangarajan Committees on Poverty (Salient Points only) – Poverty Eradication Programme (IRDP, PMGAY, MGNREGA).

Unit III: International Trade Policy and Institutions

India's Trade Policy – Special Economic Zones – Foreign Investment Policy – Foreign Exchange Rate Policy – FEMA – Globalisation and WTO – International Financial Institutions: IMF, IBRD and ADB.

Unit IV: Indian Money Market

Money Market: Features and instruments – Banking Sector Reforms – Primary Market Reforms – Inflation and controlling measures in India

Unit V: Federal Financial System in India

Federal Structure – Consolidated and Contingency Funds of India – Public Account – Centre – State Financial Relation – Finance Commission – GST and GST Council - Fiscal Sector reforms in India – State Finances – Fiscal

Responsibility and Budget Management (FRBM) Act - Local Finances.

Suggested topics for group discussion/ Presentation

NITI Aayog differs from Planning Commission in terms of composition and powers.

Poverty estimation suffers from various methodological issues.

International Monetary Fund (IMF) provides international liquidity.

Indian Banking Sector reform measures are based on Basel- III norms.

State governments are suspicious of the motives of the government of India in raising and sharing of tax revenues with them.

Suggested Readings

Text Books

1. Ramesh Singh(2019), Indian Economy for Civil services, Universities and other Examinations, McGraw Hill Education, New Delhi.
2. Misra and Puri, (2019), Sectoral Problems Of Indian, Economy, Himalayas Publishing House.
3. Rudder Datt and Sundaram, (2018), Indian Economy, S. Chand, New Delhi.

Reference Books

1. Francis Cherunilam, (2019) International Trade and Export Management, Himalaya Publishing House.
2. Uma kapila (Ed.) (2018), Indian Economy since independence, Academic Foundation, New Delhi, 29 th edition.
3. Gupta. K. R and Manoranjansharma (2018) , Indian Economic Policies and Data McGraw Hill Publications.
4. Abhijit, V. Banerjee et al. (2017), poverty and income distribution I India, juggernaut, New Delhi.
5. Prakash B.A (2009) , The Indian Economy since 1991, Edited Book, Pearson Education New Delhi.

6. Iswar C. Dhinkara, (2009) , The Indian Economy: Environment and Policy, Sultan Chand and Co.
7. Manmohan Agarwal and Amit shovon Toy, (2007) ,Globalisation and the Millinnium Development Goals, Orient Black Swan, Hyderabad.
8. Brahmananda, P. R, and V. R. Panchmuki (Eds) (2001), Development Experience in the Indian Economy: Inter-state Respective, Bookwell, Delhi.
9. Ahuluwalia, I. J and I. M. D. Little (Eds) , (1999), India's Economic Reforms and Development, oxford Universities Press, New Delhi.
10. Agarwal, A.N, (1981), Indian Economy, Vishwa prakashan, New Delhi.

Web Sources

1. https://www.vedantu.com/commerce/national-income
2. https://en.m.wikipedia.org/wiki/Demographics_of_India
3. https://en.m.wikipedia.org/wiki/Federation

DEPARTMENT OF COMMERCE - PG - CBCS - LOCF

Title of the Paper: Entrepreneurship Development (NME) Semester: III
Course Code: LPCONM31 Contact Hours: 5hrs/w Credit: 4

Course Learning Outcome:

On completion of the course, the students are able to

- know the factors affecting entrepreneurial growth.
- identify the problems faced by women entrepreneurs.
- identify the various institutional support to the entrepreneur.
- advocate for subsidy and incentives to be received from the Government.
- prepare the project reports.

Pre-required knowledge:

- ✓ Entrepreneurial venture
- ✓ Scope for women entrepreneurship
- ✓ Financial assistance from government

Unit- I: Introduction to Entrepreneurs

Entrepreneur - Definition - Concept - Characteristics - Qualities - Classification of entrepreneurs - Entrepreneur Vs Manager - Role of Entrepreneurs in the economic development -- Factors affecting entrepreneurial growth. **Entrepreneurship**- Concept - Distinction between Entrepreneur and Entrepreneurship

Unit- II: Women Entrepreneurs

Introduction - Definition - Problems - Suggestions to overcome - Government steps towards Women Entrepreneurs - Institutions support to women Entrepreneurs in India.

Entrepreneurship Development Programmes (EDP):Meaning - Objectives - Stages in EDP- Pre-training Stage - Training phase - Post Training - Evaluation and Feedback of EDP.

Unit- III : Assistance to Entrepreneurs:

Financial and Non-Financial Institutions - TIIC and SFC - DIC - SIDBI - SIDCO - Commercial Banks.

Unit- VI : Incentives and Subsidies:

Incentives and subsidies of State and Central Govt - Objectives -Aims - Tax Concession - Assistance to MSME's - Backward areas - Industrial Estates

Unit-V : Project Report:

Meaning - Steps - Contents - Reasons for failure of a Project Report – Format – Guidelines.

Suggested Topics/Practical Exercises:

The learners are required to

- ✓ list the various factors affecting entrepreneurial growth.
- ✓ explain the steps to overcome the problem face by women entrepreneur.
- ✓ name any two financial institutions supporting entrepreneurs to grow in Tamilnadu.
- ✓ cite examples for the growth of business using Seed Capital Assistance / Scheme.
- ✓ draw a project report for a new business concern.

Suggested Readings:

(i) Text Books

1. Gupta.C.B. (2018). Entrepreneurship Development. New Delhi: Sultan Chand and Sons.
2. Gordon. E. and Dr. Natarajan. K. (2020). Entrepreneurship Development. Mumbai: Himalaya Publising House.

(ii) Reference Books

1. Gupta . C.B.& Srinivasan. N.P. (2018), Entrepreneurship Development. New Delhi: Sultan Chand and Sons.
2. Khanka S.S. (2018) Entrepreneurial Development. New Delhi: S.Chand & Company Ltd..
3. Kanishka Bedi. (2012). Management and Entrepreneurship, New Delhi: Oxford University Press.

(iii) Web-Sources:

1. www.tiic.in
2. www.sidco.in
3. www.dic.in

DEPARTMENT OF CHEMISTRY – PG – CBCS-LOCF

Title of the paper: Chemistry for All (NME) **Semester: III**
Course Code:LPCHNM31 **Contact Hours: 5hrs/w** **Credits: 4**

Course Learning Outcomes:

On completion of the course, the students are able to

- ✓ know the basic chemistry involving types of elements and chemical reactions.
- ✓ study different concepts of acids and bases and various chemical processes
- ✓ gain awareness on Pollution and types of pollution
- ✓ know the details of plastics, glass, cement, types of fuels
- ✓ gain knowledge in vitamins, food adulterants and Classificationand biological functions of antibiotics

Pre-Required Knowledge

- ✓ Properties of Metals and non-metals
- ✓ Isotopes, Isobar and isotones
- ✓ Stability of Colloidal solution
- ✓ Thermosetting and thermoplastics
- ✓ Green house effect and global warning

Unit I: BASIC CHEMISTRY- I

Elements – atoms and molecules – Metals and non metal – metaolloid, alloy, ore and minerals - Chemical formulae and symbols – Important basic terms such as pressure, volume, atomic mass, molecular mass, temperature, atomic number – Types of chemical reactions (exothermic and endothermic, Physical and chemical changes, oxidation and reduction) – ideal and real gas - Important laws of Chemistry (Boyle's law, Charle'slaw, Hess's law, Grahams law of diffusion, Beer's law, Henry's law, Faraday's law, Law of conservation of matter or energy).

Unit II: BASIC CHEMISTRY- II: (Only elementary idea can be given)

Different concepts of Acids and Bases (Arrhenius, Bronsted and Lewis) – pH concept (no calculation) – Water – Hard and soft water - Chemical nature of metals- Steel and iron (no manufacture) – heat treatment of steel – Solutions and their types (True, Colloidal and suspension) – uses of colloidal solution – Buffer solution – Nuclear Chemistry – isotopes and radioactivity Definitions of some important chemical processes (Haber's, Contact's, Ostwald's, Processes)

Unit III: ENVIRONMENTAL CHEMISTRY

Pollution and types of pollution – Composition of atmosphere – Major regions of atmosphere and their characteristics – Elementary idea of Green house effects and Acid rain – Air pollution – Control of air pollution and their harmful effects – CFC, Global warming, substitute for CFC (Just name only)-Water pollution – Dissolved oxygen – BOD, COD and TDS (elementary idea only)

Unit IV: CHEMISTRY IN SERVICE OF MAN –I: (Only elementary idea can be given)

Plastics – Classification with examples – Polymer (natural and synthetic) – Soaps and Glass – Annealing of glass – Cement – Constituents and setting and hardening of cement – Rubber – Types with examples and vulcanization of rubber- Corrosion of metal – prevention – Lubricants (definition and classification) – Fuel – Classification with suitable examples - calorific value – LPG and Rocket fuel.

Unit V: Chemistry in service of man –II: (Only elementary idea can be given)

Food adulterants – common food adulterants and their harmful effects and tests to identify them– Classification and biological functions of Vitamins A, B6, B12, C, D, E and K (structural elucidation not required) – Classification and biological functions of antibiotics – penicillin, chloroamphenicol, streptomycin and tetracycline.

SUGGESTED TOPICS FOR GROUP DISCUSSION/ PRESENTATIONS

- ✓ Metals and nonmetal
- ✓ Steel and iron
- ✓ Green house effects
- ✓ vulcanization of rubber
- ✓ organic and Inorganic pesticides

Suggested Readings

Text Books:

1. A Text book of Environmental Chemistry, O.D.Tyagi, M. Mehra, Anmol Publication, 1990.
2. Puri, Sharma and Pathania, Principles of Physical Chemistry, Vishal Publishing Co., 2004
3. Puri, Sharma and Pathania, Principles of Inorganic Chemistry, Vishal Publishing Co., 2004

Reference Books:

1. Applied Chemistry, K. BagawathiSundari, MJP Publishers, Chennai – 2006.

2. General Studies Manual, The TMH Publishers, 2008
3. Basic concepts of chemistry (HB) by Pegasus sold by Amazon Asia-Pacific Holdings Private Limited, 2018.

Websites and e-Learning Sources:

1. https://youtu.be/eJXL0IrbtqE
2. https://2012books.lardbucket.org/pdfs/beginning chemistry.pdf
3. https://youtu.be/J0v3stz7izA
4. https://youtu.be/EyBkPwsRY2E
5. https://youtu.be/yU3GwJu_yNA
6. https://youtu.be/uMBeXHnWhsE
7. https://youtu.be/lUg7r7fu_eo
8. https://youtu.be/eJXL0IrbtqE

DEPARTMENT OF BOTANY - PG - CBCS - LOCF

Title of the Course: Plants and Human Welfare (NME)		**Semester: III**
Course Code: LPBYNM31	**Contact hours: 5hrs/w**	**Credit:4**

Course Learning Outcomes:

On completion of the course, the students are able to

- acquire knowledge on Plants as food
- understand the cultivation of mushrooms.
- recognize the need of plant drugs.
- familiarize with the wood and its types.
- come to know about the Organic farming.

Pre-required knowledge:

- Plant groups
- Raw drugs
- Farming techniques

Unit I: Plants as food

Importance of plant genetic resources and utilization. Present status of resources in India. Agricultural, vegetable,

horticultural and medicinal plants. Higher plants as food - Cereals- Rice, Pulses- Pigeon pea.

Unit II: Cultivation of mushrooms – *Pleurotus*

General characters of mushroom – present status of the mushroom industry in India common edible and non-edible mushrooms. Nutritive and Energy value of edible mushrooms.

Unit III: Biological Drugs

Brief history and scope of raw drugs of plant origins. Definition, herbals, classification and description. Classification of vegetable drugs. Biological sources of drugs.

Unit IV: Timbers

Structure of wood, sap wood – heart wood transition, properties of wood (Physical, chemical & mechanical). Dendrochronology and its significance. Commercial uses of woods of South India - Teak (*Tectona grandis*), Neem (*Azadirachta indica*).

Unit V: Organic farming

Organic farming, vermin-composting. Leguminous plants in green manuring. Biofertilizer -*Rhizobium* and Blue green algae (*Nostoc*); Biopesticides: *Bacillus thuringiensis*.

Suggested Topics for Seminar/Presentation/Group Discussion:

- Plants as food
- Recent methods for mushroom cultivation
- Biological sources of drugs
- Dendrochronology and its significance
- Techniques of vermicomposting and Methods of organic farming

Suggested Readings:

Text Books:

1. Albert F. Hill. (1952). Economic Botany. Tata McGraw-Hill Publishing Company Ltd., New Delhi.
2. PradeepSachdeva. (2014). A Naturalists Guide to the Trees & Shrubs of India. *Prakash books* Publishers, Chennai. ISBN: 978817599408.

3. Board Eiri (2008) Hand Book of Tree Farming. *Engineers India Research Institute Publishers*. New Delhi.
4. Suman, B.C. & Sharma, V.P. (2007). Mushroom cultivation in India. *DayaPublishingHouse*, Delhi.

Reference Books

1. Dorian Q. Fuller, Eleni Asouti.(2008)Trees and Woodlands of South India. *Munshiram Manoharlal Publishers*. New Delhi. ISBN: 9788121512145.
2. Sanjay Tiwari, and Nikhil Devasar. (2019). 100 Indian Trees: The Big Little Nature Book. *DK India publishers*, New Delhi.
3. NeginhalS.G. (2020). Forest Trees of South India. *Notion Press publishers*, Chennai.
4. Diego Cunha Zied, Arturo Pardo-GimAcnez. (2017). Edible and Medicinal Mushrooms: Technology and Applications. *John Wiley & Sons*.
5. Kochhar, S.L. (1981). Economic Botany in the Tropics. *McMillan India Ltd*., Madras.
6. Mukharjee, S.K. (1969). Survey of Plants of India. Bull. *Botanical Survey India*, 11(3): 217-223.
7. Sambamurthy, A.V.S.S. and N.S. Subramaniyam. (1989). A Textbook of Economic Botany. *Wily Eastern Ltd*., New Delhi.
8. Albert E Hill and O P Sharma (1996). Economic Botany. *Tata McGraw Hill Co. Ltd*., New Delhi.
9. Anonymous. (1948-1976). The Wealth of India - A Dictionary of Indian Raw Materials and Industrial Products. Vol. I to X. *Publication and Information Directorate, CSIR*, New Delhi.

Web Sources:

1. https://byjus.com/biology/food-sources-animal-plant-products/
2. https://foodplantsinternational.com/
3. https://namyco.org/mushroom_cultivation_resources.php
4. https://www.fs.fed.us/wildflowers/ethnobotany/medicinal/index.shtml

DEPARTMENT OF PHYSICS – PG – CBCS - LOCF

Title of the Course: Physics for Competitive Examinations (NME)		**Semester: III**
Course Code: LPPHNM31	**Contact Hours: 5hrs/w**	**Credit: 4**

Course Learning Outcomes:

On completion of the course, the students are able to

- understand various systems of units and newton's laws of motion
- acquire the basic knowledge on gravitation
- understand the various aspects in electrostatics and electricity
- have knowledge on various properties of light
- understand the electronic devices, circuits and various number systems

Pre-Required Knowledge:

- ✓ Gravitational force, acceleration due to gravity mass and other physical quantities
- ✓ Heat, energy, temperature, basic mathematics, basic ideas on charge and current
- ✓ Elementary idea on planetary systems and space

Unit I: Systems of Units and Newton's Laws

System of units S.I.- Fundamental units- derived units – Dimension of physical quantity – uses of dimensional equations – limitation of dimensional analysis. Force and

inertia, Newton's first law of motion – momentum – second law of motion – conservation of linear momentum – Newton's Third law of motion – friction – laws of limiting friction – static and dynamic friction.

Unit II: Gravitation

Gravitation-Kepler's law of planetary motion – universal law of gravitation – acceleration due to gravity – variation of 'g' at poles – equator – Altitude – depth – rotation of earth – difference between mass and weight – Inertial mass and gravitational mass –Satellite – Orbital velocity – escape velocity – Rocket.

Unit III: Electrostatics and Electricity

Charge and fields – Coulomb's law – electric field due to a point charge – Gauss law – Application of Gauss law – Electric field due to parallel sheet of charge – Electric potential –Potential due to a point charge – Capacitor – Principle of a capacitor – Capacitance of a parallel plate capacitor –Effect of dielectric on capacitance – current and resistance – Electric current –Current density – Expression for current density – Ohm's law and electrical conductivity – Kirchoff's law – Application of Kirchhoff's law to Wheatstone network and measurement of resistance.

Unit IV: Optics and Sound

Light – Reflection of light – Laws of reflection – Refraction of light – Laws of reflection – Dispersion visible range dual nature – Total internal reflection – Laser – Interaction of light with matter – Population inversion - Applications of laser. Simple Harmonic motion – Progressive wave properties – stationary waves – properties – ultrasonic – Properties and applications.

Unit V: Electronics

Difference between conductor, insulator and semiconductor using band theory – Intrinsic and extrinsic semiconductor – semiconductor diode –diode as a rectifier – Photo diode – LED – Zener diode as a voltage regulator – Number system – Binary, octal, Hexadecimal – Inter conversion – Cray code – exes 3 code , ASCII code – Basic

gates – De-Morgan's theorem – Universal gates – Binary addition –Binary subtraction – 2's complement method - 1's complement method – binary multiplication – binary division.

Suggested Topics for Group Discussion/Presentation:

- ✓ Newton's laws of motion, concept of friction and its associated quantities
- ✓ Newton's law of Gravitation-Kepler's law of planetary motion,
- ✓ Electrostatics force, Electric field, electric potential, capacitors. Ohm's law Kirchoff's law
- ✓ Various properties of light, laser fundamentals and applications, Ultrasonics and applications.
- ✓ Various types of semiconductor devices, binary number systems

Suggested Readings:

(i) Text Books:

1. Murugeshan, R. Mechanics, Properties of matter and sound. For Bsc ancillary physics, Reprint (2016).
2. Murugeshan, R. Optics, Spectroscopy and Modern Physics, For Bsc ancillary physics, 1st edition (2017).
3. Murugeshan, R. Electricity and electronics, for B.Sc Ancillary Physics, 1st edition, (2014).

(ii) Reference Book:

Halliday, D. Resnick, R and Walker, J. Principle of Physics, International Student version, Wiley India Private Ltd., 9th edition, reprint (2012).

(iii) Web Sources:

1. https://www.khanacademy.org/science/physics
2. https://ocw.uci.edu/courses/physics_3a_basic_physics.html
3. https://www.concepts-of-physics.com/dr-hc-verma/videos.php#hc-verma-videos-on-mechanics

Title of the Course: Complex Analysis		Semester: IV
Course code: LPMSCT41	Contact Hours: 6hrs/w	Credits: 5

Course Learning Outcomes:

On completion of the course, the students are able to

- understand the concepts of analyticity.
- acquire knowledge of integrals and residues.
- learn its applications.
- define and Evaluate complex integration.
- determine and Analyze the calculus of residues**.**

Pre required knowledge:

- ✓ Operations in Complex numbers.
- ✓ n^{th} root of a Complex number.
- ✓ Concept of Analytic Functions.

Unit I: Complex Numbers

The algebra of Complex numbers - The geometric representation of complex numbers.

Unit II: Complex Functions

Introduction to the concept of analytic function - Elementary theory of power series - The exponential and trigonometric functions.

Unit III: Analytic Functions as Mappings

Conformality – Linear transformations- Elementary Conformal mapping.

Unit IV: Complex Integration

Fundamental theorems - Cauchy's integral formula - Local properties of analytical functions.

Unit V: Calculus of Residues

The general form of cauchy's theorem - The calculus of residues – Harmonic functions - Power series expansions.

Suggested Topics for Group Discussion/ Presentation:

1. Spherical representation
2. Exponential and Trigonometric functions
3. Cross Ratio

4. Cauchy's theorem for a Rectangle
5. Evaluation of definite Integrals

Suggested Readings:

(i) Text Book:

Lars V.Ahlfors, Complex Analysis, Third Edition, McGraw Hill Education (India) Private Limited, New Delhi, 2013.

Unit I : Chapters 1, sections 1,2

Unit II: Chapters 2, sections 1,2,3

Unit III: Chapters 3, sections 2,3,4

Unit IV: Chapter 4, sections 1,2,3

Unit V: Chapter 4, sections 4,5,6 , Chapter 5, section 1

(ii) Reference books:

1. Karunakaran , V., Complex Analysis, Narosa Publishing House Private Limited, Second Edition , New Delhi , 2006.
2. Ponnusamy, S., Foundations of Complex Analysis, Narosa Publishing House Private Limited, New Delhi, 2013.
3. Theodore Gamelin, Complex Analysis, Springer, 2012.

(iii) Web Resources:

1. https://www.google.com/url?sa=t&source=web&rct=j&url=https://www3.nd.edu/~atassi/Teaching/ame60612/Notes/analytic_functions.pdf&ved=2ahUKEwiXy_rEorT2AhUIklYBHWdDAeMQFnoECAQQBg&usg=AOvVaw2p6CqMPeN9tF7E4LJ3l4i8
2. https://www.google.com/url?sa=t&source=web&rct=j&url=https://www.maths.ed.ac.uk/~jmf/Teaching/MT3/Complex Analysis.pdf&ved=2ahUKEwiXy_rEorT2AhUIklYBHWdDAeMQFnoECAwQAQ&usg=AOvVaw2AWK9jN1fi4H9ldTXsQ1mk
3. https://www.google.com/url?sa=t&source=web&rct=j&url=https://complex-analysis.com/content/complex_integration.html&ved=2ahUKEwjd-6CCo7T2AhUvslYBHWf5DOQQFnoECDYQAQ&usg=AOvVaw0HH9NQXnqcHfmBYc-NVFJD

Title of the Course: Number Theory		Semester: IV
Course Code: LPMSCT42	Contact hours: 6hrs/w	Credits: 5

Course Learning Outcomes:

On completion of the course, the students are able to

- demonstrate and apply division algorithm in integers and define factorization using primes,
- define and illustrate arithmetic functions and also analyze their properties,
- classify and Solve the Chinese Reminder problem using congruences,
- determine Quadratic residues,
- recall prime factorization and solve special types of Diophantine equations.

Pre required knowledge:

- ✓ Set theory and relations
- ✓ Functions and series
- ✓ polynomials

Unit I: The Fundamental Theorem of Arithmetic

Introduction-divisibility-greatest common divisor-prime numbers - the fundamental theorem of arithmetic-the series of reciprocals of the primes-the Euclidean algorithm-the greatest common divisor of more than two numbers.

Unit II: Arithmetical Functions and Dirichlet Multiplication

Introduction –the Mobius function $\mu(n)$-the Euler Totient function $\varphi(n)$ - A relation connecting μ and φ-a product formula for $\varphi(n)$-the Dirichlet product of arithmetical functions-Dirichlet inverses and Mobius inversion formula-the Mangoldt function $\Lambda(n)$-the multiplicative functions-Dirichlet multiplication-the inverse of a completely multiplicative functions-Liouville's function $\lambda(n)$-the divisor functions$\sigma_\alpha(n)$-generalized convolutions-formal power series-The bell series of an arithmetical function-Bell series and Dirichlet multiplication-derivatives of arithmetical functions-the Selberge identity.

Unit III: Averages of Arithmetical Functions

Introduction- the big oh notation, asymptotic equality of functions-Euler summation formula-some elementary asymptotic formulas-the average order of d(n)-the average order of the divisor function $\sigma_\alpha(n)$-the average order of $\varphi(n)$-an application to the distribution of lattice points visible from the origin-the partial sums of Dirichlet product-application to $\mu(n)$ and $\Lambda(n)$- another identity for the partial sums of a Dirichlet product.

Unit IV: Congruences

Definition and basic properties of congruences-residue classes and complete residue systems-linear congruences-reduced residue systems and Euler-Fermat theorem-polynomial congruences modulo p. Langranges theorem-applications of Lagrange's theorem-simultaneous linear congruences. The Chinese remainder theorem-applications of Chinese remainder theorem-polynomial congruences with prime power moduli-the principle of cross classification-a decomposition property of reduced residue systems.

Unit V: Some Elementary Theorems on the Distributions of Prime Numbers

Introduction-Chebyshev's functions-relations connecting $\psi(x)$ and $\theta(x)$- some equivalent forms of the prime number theorem-quadratic residues-Legendre's symbol and its properties-evaluation of (-1/p) and (2/p)-Gauss lemma- the quadratic reciprocity law-applications of the reciprocity law-the Jacobi symbol-applications to Diophantine equations.

Suggested Topics for Group Discussion/ Presentations:

1. Euclidean Algorithm
2. Formal power series
3. The distribution of lattice points
4. Congruence
5. Quadratic residues

Suggested Readings:

(i)Text Book:

Tom M.Apostol, Introduction to Analytic Number Theory, Narosa Publishing House, 1989.

Unit I (Chapter 1)
Unit II(Chapter 2)
Unit III (Chapter 3)
Unit IV (Chapter 5)
Unit V (Chapter 4: sections 4.1 to 4.4 and Chapter 9 sections: 9.1 to 9.8)

(ii) Reference books:

1. Ivan Niven, Herbert S. Zuckerman and Hugh L. Montgomery ,An Introduction to analytic number theory John Wiley and sons Inc., Third edition, 1972.
2. David M. Burton, Elementary Number Theory, Tata McGraw-Hill Education Pvt. Ltd., Sixth Edition, New Delhi, 2010.
3. George E. Andrews,Number Theory, Hindustan Publishing Corporation, New Delhi, 1992.
4. Martin Erickson and Anthony Vazzana, Introduction to Analytic Number Theory, Chapman and Hall /CRC Publications, New Delhi, 2009.

(iii) Web Resources:

1. https://home.sandiego.edu/~aboocher/writings/NumberTheoryNotes.pdf
2. http://www.freebookcentre.net/Mathematics/Number-Theory-Books.html
3. https://www.youtube.com/watch?v=SCvtxjpVQms&list=RDCMUC640y4UvDAlya_WOj5U4pfA&start_radio=1&rv=SCvtxjpVQms
4. https://youtu.be/19SW3P_PRHQ

Title of the Course: Statistics – II **Semester: IV**

Course Code: LPMSCT43 **Contact hours: 6hrs/w** **Credit: 4**

Course Learning Outcomes:

On completion of the course, the students are able to

- understand problems of statistical inference, problem of testing of hypothesis, Properties of point estimator such as consistency, Unbiasedness, Sufficiency.
- understand estimators using estimation methods such as Maximum likelihood Minimum chi Square , Method of moments , Method of scoring, Properties of maximum likelihood estimator, Quantify information in statistic using Fisher information.
- understand minimal sufficient statistic and minimal sufficient statistic for exponential family.
- apply the concept of Rao-Blackwell theorem and complete family Construct confidence.
- explain Certain best tests, Uniformly most powerful tests, Likelihood ratio tests, The sequential probability ratio test.

Pre Required Knowledge:

- ✓ Probability set theory
- ✓ Chi–square test
- ✓ Some Limiting distribution theory, Bivariate Distribution

Unit I: Estimation theory

Point estimation – Confidence interval for means – Confidence intervals for differences of means.

Unit II: Chi – square test

Tests of Statistical hypotheses – Additional comments about statistical tests – Chi – square tests.

Unit III: Sufficient Statistics

Measures of sufficient statistic quality of estimators – A sufficient statistic for a parameter – Properties of a– Completeness and uniqueness – The exponential class of probability density functions – Functions of a parameter.

Unit IV: More About Estimation

Bayesian estimation – Fisher information and the Rao – Cramer inequality – Limiting distribution of maximum likelihood estimators.

Unit V: Theory of Statistical Test

Certain best tests – Uniformly most powerful tests – Likelihood ratio tests – The sequential probability ratio tests.

Suggested Topics for Group Discussion/ Presentation:

1. Confidence intervals for differences of means.
2. The exponential class of probability density function.
3. Tests of Statistical hypotheses
4. Fisher information and the Rao – Cramer inequality Tests.
5. Uniformly most powerful tests.

Suggested Readings:

(i) Text Book:

R.V. Hogg and A.T.Craig, Introduction to Mathematical Statistics, Fifth Edition, Pearson Education, 2005.

Unit I: Chapter 6, Sections 6.1 to 6.3

Unit II: Chapter 6, Sections 6.4 to 6.6

Unit III: Chapter 7, Sections 7.1 to 7.6

Unit IV: Chapter 8, Sections 8.1 to 8.3

Unit V: Chapter 9, Sections 9.1 to 9.4

(ii) Reference books:

1. A. M. Mood, F. A. Gray Bill and D. C. Boes, Introduction to The Theory of Statistics, TataMcGraw-Hill Publication, Third Edition, 2005.
2. John E. Freund, Mathematical Statistics, Prentice-Hall of India, Fifth Edition, 1992.
3. Bhat B.R, An Introductory of Modern probability Theory , Third Edition (Reprint), New Age International PVT, New Delhi(2009).
4. Rohatgi V.K. and Saleh, An Introduction to Probability and Statistics , AKME, Third Edition, John Wiley&Sons , NY(2015).
5. Mukhopadhyay P, Mathematical Statistics , Third Edition ,Books and Allied (P) LMT, Kolkata(2006).

(iii) Web Resources:

1. https://youtu.be/Bwvv7UMOeWw
2. https://sphweb.bumc.bu.edu/otlt/mph-modules/bs/bs704_confidence_intervals/bs704_confidence_intervals5.html
3. https://uk.sagepub.com/sites/default/files/upm-assets/82020_book_item_82020.pdf
4. http://course.sdu.edu.cn/G2S/eWebEditor/uploadfile/20140110135342002.ppt
5. https://people.missouristate.edu/songfengzheng/Teaching/ MTH541/Lecture%20no tes/Fisher_info.pdf
6. https://www.youtube.com/watch?v=igQIsYAlKlY
7. https://www.youtube.com/watch?v=i0JiSddCXMM

Title of the Course : Project **Semester: IV**
Course Code: LPMSPJ41 **Contact Hours: 5hrs/w** **Credits: 4**

Course Learning Outcomes:

On completion of the course, the students are able to

i) know about research methodology
ii) know about literature survey.
iii) learn to choose research topic of interest
iv) develop their work into main research
v) to explore and engage in research in Mathematics

PROCEDURE

- Projects are to be done by groups of students with a maximum of five students
- in a group.
- The thesis should be neatly typed in Times New Roman Font of Font Size 12
- Repetition in choosing topic of project from previous project is not allowed.
- Project should consist the following sections.
  i) Introduction
  ii) Preliminaries

iii) Indepth study of Project
iv) Results and Theorems
v) Applications (if any)
vi) Conclusion
vii) References

During project hours students may visit University Departments or any relevant Departments, Institutions related to their projects after getting prior permission from the Head of the Department. The report of visit should be submitted on the next working day of visit.

Title of the Course: Advanced Topology **Semester: IV**
Course Code: LPMSDS41 **Contact hours: 5hrs/w** **Credit: 3**

Course Learning Objectives:

On completion of the course, the students are able to

- classify various compactifications.
- analyse metrization theorems.
- examine complete metric spaces
- categorize pointwise and compact convergence
- know now here differentiable functions and Baire spaces.

Pre Required Knowledge

- ✓ Knowledge of Topological spaces.
- ✓ Knowledge of complete metric spaces and compact metric spaces.
- ✓ Knowledge of metrigable spaces.

Unit I: The Stone-Cech Compactification

The stone-cech compactification-Local finiteness.

Unit II: Metrization Theorems and Paracompactness

The Nagata - Smirnov metrization theorem - Paracompactness - The Smirnov metrization theorem.

Unit III: Complete Metric Spaces and Function Spaces

Complete metric spaces-A space filling curve.

Unit IV: Complete Metric Spaces and Function Spaces Continued

Compactness in metric spaces- Pointwise and compact convergence- Ascoli's theorem.

Unit V: Baire Spaces

Baire spaces-A nowhere differentiable function.

Suggested Topics for group discussion/ Presentation

1. Local finiteness
2. Paracompactness
3. Complete metric spaces
4. Compact convergence
5. Baire spaces

Suggested Readings

(i)Text Book:

James R.Munkres, "Topology",second Edition, Prentice Hall of India Private Ltd, New Delhi,2000.

Unit 1 : Chapter 5: section 38.

Unit 2 : Chapter 6: section 39, 40,41 and 42.

Unit 3 : Chapter 7: section 43,44

Unit 4 : Chapter 7 :Section 45,46 and 47.

Unit 5 : Chapter 8: section 48 and 49.

(ii) Reference books:

1. G.F.Simmons, Introduction to Topology and Modern Analysis, Tata Mcgraw-Hill Publishing Company Ltd, New Delhi, 5th Reprint – 2006**.**
2. Fred H.Croom, Principles of Topology, Cengage India Pvt. Ltd., New Delhi 2009.
3. Seymour Lipschutz, Theory and Problems of General Topology, McGraw-Hill Edition, New Delhi. 2006.
4. Chandrasekhara Rao. K.,Topology, Narosa Publishing House, New Delhi, 2012.
5. Chatterjee. D., Topology General & Algebraic, New Age International, Chennai, 2007.
6. Deshpande. J.V., Introduction to Topology, Tata McGraw-Hill, New Delhi, 1998.

(iii) Web Resources:

1. https://nptel.ac.in/courses/111/101/111101152/
2. https://www.youtube.com/watch?v=04pvLCDbq1c
3. https://www.youtube.com/watch?v=JySFgR0cjLA
4. https://www.youtube.com/watch?v=lbRkRQqkij8

Title of the Course: Modern Applied Algebra		Semester: IV
Course Code: LPMSDS42	Contact hours: 5	Credit: 3

Course Learning Outcomes:

On completion of the course, the students are able to

- acquire the knowledge of Applied Algebra.
- understand the concepts of Block Structures in ALGOL and Logic.
- acquire the knowledge of Boolean
- understand the concepts of logic gates
- analyze the concept of encoding and decoding

Pre Required Knowledge:

- ✓ Fundamental concepts of group structure.
- ✓ Basic concepts of logic and & relations.
- ✓ Fundamental knowledge of arithmetic expressions.

Unit I: Finite State Machines

Introduction, Binary devices and states, finite state machines, Covering and equivalence, Equivalence state, A minimization procedure, Turing machines, Incompletely specified machines.

Unit II: Programming Languges

Introduction, Arithmetic expressions, Identifiers: assignment statements, arrays, For statements, Block structures in ALGOL, The ALGOL grammar, Evaluating arithmetic statements, compiling arithmetic expressions.

Unit III: Boolean Algebras

Introduction, Order, Boolean polynomials, Block diagrams for gating networks, Connections with logic, Logical capacities

of ALGOL, Boolean algebra, Boolean sub algebras, Disjunctive normal form, direct products, morphism.

Unit IV:Optimization and Computer Design

Introduction, Optimization, Computerizing optimization, Logic design, NAND gates and NOR gates, The minimization problem, Procedure for deriving prime amplicants, Consensus taking, Flip-flops, Sequential machine design.

Unit V: Binsary Group Code

Introduction, Encoding and decoding, Block codes, Matrix encoding techniques, Group codes, Descending tables, Hamming codes.

Suggested Topics for Group Discussion/ Presentation

1. Finite state machine
2. Arithmetic expressions and identifiers
3. Boolean algebra
4. Minimization problem
5. Matrix encoding techniques

Suggested Readings:

i) Text Book

1. G. Birkhoff and T.C. Bartee, Modern Applied Algebra, CBS Publishers and Distributors, New Delhi, 1987

Unit 1 : Chapter 3 Sections 3.1 to 3.9

Unit 4 : Chapter 4 Sections 4.1 to 4.9

Unit 3 : Chapter 5 Sections 5.1 to 5.10

Unit 4 : Chapter 6 Sections 6.1 to 6.10

Unit 5 : Chapter 8 Sections 8.1 to 8.7

ii) Reference Books

1. P.Pundire, Modern Applied Algebra, Pragati Publication, 2007.
2. M.Artin, Algebra, Prentice Hall of India Private Limited,2005
3. Mahima Ranjan Adhikari, Avishek Adhikari, Basic Modern Algebra With Applications, Springer

(iii) Websites and e-Learning Sources

1. https://ocw.mit.edu
2. https://web.standford.edu
3. https://openstax.org
4. https://libguides.alfasisal.edu
5. https://www.khancademy.rg

Title of the Course: Advanced Functional Analysis **Semester: IV**
Course Code:LPMSSE41 **Contact hours: 2hrs/w** **Credit: 2**

Course Learning Outcomes

On completion of the course, the students are able to

- understand the knowledge of Functional Analysis.
- understanding the concepts and construct the various Compact operatorand Bounded operator
- gain the knowledge of inner product Spaces and properties
- constructs the various operators.
- apply the Involutions in Banach algebras.

Pre Required Knowledge:

- ✓ The basic knowledge of compact operators.
- ✓ Fundamental of Inner Product Spaces.
- ✓ Learn the Regular and singular elements.

Unit I: Compact linear maps

Compact operators on Normed spaces Compact linear maps – Spectrum of a compact operator – Fredholm Alternative.

Unit II: Geometry of Hilbert Spaces

Projection and Riesz representation theorems - Bounded operators and adjoints.

Unit III: Bounded Operators on Hilbert Spaces

Normal, Unitary and Self – Adjointoperators- spectrum and numerical range.

Unit IV: Banach Algebras

General Preliminaries on Banach Algebras- The definitions and some examples - Regular and singular elements- Topological divisors of zero – The spectrum – The formula for spectral radius.

Unit V: The Gelfand mapping – Applications

The Gelfand mapping – Applications of the formula $r(x) = \lim||x^n||^{1/n}$ – Involutions in Banach algebras – The Gelfand Neumark theorem.

Suggested Topics for Group Discussion/ Presentation:

1. Curvature and torsion of a curve
2. Fundamental existence theorem for space curves
3. Canonical geodesic equations
4. Bonet theorem
5. Lines of curvature

Suggested Readings:

(i) Text Book:s

1. Balamohan V. Limaye Functional Analysis, New age international Publishers Revised Second Edition, New Delhi 1996.
   Unit I: Chapter 5 : Sections 17,18 and 19.
   Unit II: Chapter 6: Section 24, Chapter 7: Sections 25.
   Unit III: Chapter 7: Sections 26 and 27.
2. G.F. Simmons, Introduction to Topology and Modern Analysis, Tata Mcgraw - Hill Publishing Company Ltd, New Delhi, 5th Reprint – 20
   Unit IV: Chapter 12: Sections 64, 65, 66, 67 and 68.
   Unit V: Chapter 13 : Sections 70, 71, 72 and 73.

(ii) Reference books:

1. S. Ponnusamy, Foundations of Functional Analysis, Narosa Publishing House, New York 2002.
2. S. Kesavan, Functional Analysis, TRIM Series, Hindustan Book Agency, New Delhi, 2009.
3. Rajendra Bhatia, Lectures on Functional Analysis, TRIM Series Hindustan Book Agency, New Delhi, 2009.

(iii) Web Resource

1. https://www.math.uzh.ch/gorodnik/functional_analysis/lecture5.pdf
2. https://www.quantiki.org/wiki/hilbert-spaces
3. https://www.impan.pl/~pmh/teach/algebra/additional/gn.pdf

Title of the Course: Cryptography and Network Security Semester: IV
Course Code: LPMSSE42 Contact hours: 2hrs/w Credit: 2

Course learning outcomes

On completion of the course, the students are able to

- recall the Fundamentals of Cryptography.
- demonstrate standard cryptographic algorithms used to analyze confidentiality, integrity and authenticity.
- list and Identify the security issues in the network, key distribution and management schemes.
- design encryption techniques to secure data in transit networks.
- evaluate security mechanisms in theory of networks

Pre required Knowledge

- ✓ Methods of conventional encryption.
- ✓ Concepts of public key encryption and number theory.
- ✓ Hash functions**.**

Unit I: Introduction

OSI security Architecture – classical Encryption techniques – Cipher principles – Date Encryption – Block chipper design principles and modes of operation – Evaluation criteria for AES – AES ciper – Triple DES – Placement of Encryption function – Traffic confidentiality.

Unit II: Public key cryptography

Key management – Diffle – Hellman key exchange – elliptic curve architecture and cryptography – introduction to number theory – confidentiality using symmetric encryption – public key cryptography and RSA.

Unit III: Authentication and Hash function

Authentication requirements – Authentication functions – message authentication codes – Hash function – security of Hash functions and MACs – MD5 message Digest algorithm - secure Hash algorithm – RIPEMD – HMAC digital signatures – Authentication protocols – digital signature standard.

Unit IV: Network security

Authentication applications: Kerberos – X.509 Authentication service – electronic mail security – PGP-S/MIME – IP security – web security.

Unit V: System level security

Intrusion detection – password management – viruses and related threats – virus counter measures – firewall design principles – trusted systems.

Suggested topics for group discussion/presentation

1. Cipher principles
2. Introduction to number theory
3. Security of Hash functions and MACs
4. X.509 Authentication service
5. viruses and related threats

Suggested Readings

(i) Text Book:

Williams Stallings, Cryptography and Network Security, 3rd Edition, Pearson Education Publishers, 2005.

Unit 1: Chapters 1, 2, 3, 5, 7.

Unit 2: Chapters 9, 10.

Unit 3: Chapters 11, 12.

Unit 4: Chapters 14, 15, 16, 17.

Unit 5: Chapters 18, 19, and 20.

(ii) Reference books:

1. Atulkahate, “Cryptography and Network security”, Tata McGraw – Hill, 2003.
2. Bruce Schneier, “Applied cryptography”, John wiley and sons Inc, 2001
3. Charles B. Pfleeger, Shari Lawerencep fleeger, “Security in computing”, third edition, Pearson Education, 2003.

(iii) Web Resources:

1. https://nptel.ac.in/courses/106/105/106105031/
2. https://nptel.ac.in/courses/106/107/106107155/
3. https://nptel.ac.in/courses/106/105/106105031/

RULES AND REGULATIONS FOR THE PROJECT / DISSERTATION WORK (UG, PG AND M.PHIL)

- Research supervisors will be allotted to the students / scholars by the respective Department.
- Research topic shall be chosen by the student / scholar in consultation with his/ her research supervisor.
- Every department has to maintain the year-wise list of project works carried out by the students. Research works done by the students / scholars of the previous batches should not be repeated by the students / scholars of the current academic year.
- The general structure of the project report is given below.

  Title page with college emblem

  Research supervisor's certificate

  Student's declaration counter signed by Research Supervisor and the HOD

  Student's Acknowledgement

  Contents

  List of Tables if any

  Introduction

  Review of Literature

  Materials and Methods

  Results and Discussion

  Summary of Findings and Conclusion

  Bibliography

  Annexure

- Four copies of the project repot should be submitted, typed in A4 Paper in Times New Roman with the font size of 12 and 1.5 line spacing.

SARASWATHI NARAYANAN COLLEGE

(Autonomous Institution – Affiliated to Madurai Kamaraj University)

(Reaccredited with $B^{(2.78)}$ Grade by NAAC in the second cycle)

MADURAI -22

EVALUATION METHOD UNDER CBCS- LOCF

CONTINUOUS INTERNAL ASSESSMENT (CIA)

Internal assessment is based on the continuous evaluation of performance of the students in each semester. Internal mark is awarded to each course in accordance with the following guidelines.

UNDER GRADUATE, POST GRADUATE AND M.PHIL:

1. Internal test will be conducted for the maximum of 60 marks and converted to 15 marks.
2. Two internal tests will be conducted and the average of marks secured in the two tests will be taken as the Final Internal Test mark.
3. The distribution of Internal Assessment marks is given below.

THEORY			**PRACTICAL**		
Test	-	15	Record Note	-	10
Seminar	-	5	CIA	-	15
Quiz	-	5	Model Exam	-	15
		---			---
Internal Maximum	-	25	Internal Maximum	-	40

4. There is no Cumulative Internal Assessment (CIA) for Self Learning. Courses, Add on Certificate / Diploma Programmes and Part-1, subjects other than Tamil.
5. Internal marks for those UG, PG and M.Phil. students who have to Repeat the Semester (RS) for want of attendance should be marked “AA” in the foil card.
6. There is no minimum mark for Internal assessments marks for all the UG, PG and M.Phil. Programmes.

7. Internal test for improvement of marks is not allowed under any circumstances
8. Special Internal Assessment tests for the absentees may be conducted on genuine reasons with the prior approval of HOD, Dean and Principal. Such tests may be conducted before the commencement of the Summative Examinations.

SUMMATIVE EXAMINATIONS (SE)

1. Summative Examinations for all the UG, PG and M.Phil. Programmes are conducted in November and April for the Odd and the Even semesters respectively.
2. Question paper setting along with the scheme of valuation is purely external for all the UG, PG and M.Phil. Programmes.
3. The office of the CEO is conferred with the right of choosing the Question Paper Setters and the External Examiners from the Panels suggested by the Boards of Studies of Programmes offered by the respective Department and approved by the Academic Council of the College. The question papers set for the Summative Examinations will be finalised by the Scrutiny Committee constituted by the office of the COE.
4. Practical Examinations will be conducted by the External Examiner and the course teacher, who will act as the Internal Examiner. In the absence of course teacher / External Examiner, HOD will act as the Internal Examiner / External Examiner.
5. The marks scored by the students in the External Examinations in Self Learning Courses and Add – on Courses will be converted to 100 for each course.
6. The theses submitted by the M.Phil. scholars after the conduct of Awards Committee meeting can be valued and the Viva-Voce Examinations can be conducted. The Principal is empowered to declare the results and it can be ratified in the next Awards Committee meeting.

Knowledge levels for assessment of Outcomes based on Blooms Taxonomy

S. No	Level	Parameter Description	Description
1	K1	Remembering	Remembering It is the ability to remember the previously learned
2	K2	Understanding	The learner explains ideas or Concepts
3	K3	Applying	The learner uses information in a new way
4	K4	Analysing	The learner distinguishes among different parts
5	K5	Evaluating	The learner justifies a stand or decision
6	K6	Creating	The learner creates a new product or point of view

WEIGHTAGE OF K–LEVELS IN QUESTION PAPER

K-LEVELS (Cognitive Level)						Total
	K1	K2	K3	K4	K5/ K6	
SUMMATIVE EXAMINATIONS– 75 Marks Pattern	21	30	18	18	13	100
SUMMATIVE EXAMINATIONS–50 Marks Pattern	24.5	24.5	17	17	17	100
CONTINUOUS INTERNAL ASSESSMENT(CIA)	24	26	14	25	11	100

QUESTION PATTERN FOR SUMMATIVE EXAMINATIONS For those who join in June 2022 UG and PG (Language Courses, Core Courses, Discipline Specific Electives, Generic Elective Courses, Non-Major Electives(PG))	
	TOTAL MARKS 75
SECTION–A (Answer all questions) **I. Choose the correct answer (FIVE questions –ONE question from each unit)** (Q.No.1-5)-All questions are at K2 level **Fill in the blanks (FIVE questions - ONE question from each unit)** (5x1=5) (Q.No.6-10)-All questions are at K1 level	**10**
SECTION-B **Answer all questions not exceeding 50 words each**. **ONE set of questions from each unit** **Q. No. : 11 to 15** K2 level – 2 Questions K3 level – 1 Question K4 level –1 Question K5/K6 level – 1 Question	**10**
SECTION-C **Either/or type** **Answer all questions not exceeding 200 words each**. **ONE set of questions from each unit.** **Q. No. : 16 to 20** (5 x5=25) K1 level – 1 Question K2 level – 2 Questions K3 level – 1 Question K4 level – 1 Question	**25**
SECTION-D **Answer any THREE questions not exceeding 400 words each.** **ONE question from each unit.** **Q. No. : 21 to 25** (3x10=30) K1 level – 1 Question K2 level – 1 Question K3 level – 1 Question K4 level – 1 Question K5/K6 level – 1 Question	**30**
Total	**75**

QUESTION PATTERN FOR SUMMATIVE EXAMINATIONS For those who join in June 2022 UG and PG (Skill Enhancement Courses, Self Learning Courses, Non Major Electives (UG)and Part V Courses (except NCC))	
	TOTAL MARKS 50
SECTION–A (Answer all questions) **I. Choose the correct answer (FIVE questions –ONE question from each unit)** (Q.No.1-5)-All questions are at K2 level **II. Fill in the blanks (FIVE questions – ONE question from each unit)** (5x1=5) (Q.No.6-10)-All questions are at K1 level	**10**
SECTION-B **Answer all questions not exceeding 50 words each. ONE set of question from each unit** **Q. No. : 11 to 15** (5x2=10) K1 level – 1 Question K2 level – 1 Question K3 level – 1 Question K4 level – 1 Question K5/K6 level – 1 Question	**10**
SECTION-C **Answer any THREE questions not exceeding 400 words each.** **ONE question from each unit** **Q. No. : 16 to 20** (3x10=30) K1 level – 1 Question K2 level – 1 Question K3 level – 1 Question K4 level – 1 Question K5/K6 level – 1 Question	**30**
Total	**50**

QUESTION PATTERN FOR INTERNAL ASSESSMENT (CIA) For those who join in June 2022 UG and PG	
	TOTAL MARKS 60
SECTION–A(Answer all questions) **I. Choose the correct answer** (5 x 1 = 5) (Q.No.1-5)-All questions are at K2 level **II. Fill in the blanks** (5 x 1 = 5) (Q.No.6-10)-All questions are at K1 level	**10**
SECTION-B **Answer all questions not exceeding 50 words each.** **ONE set of question from each unit** (4 x 2 = 8) Q.No. 11 – K2 level Q.No. 12 – K3 level Q.No. 13 – K3 level Q.No. 14 – K5/ K6 level	**8**
SECTION-C **Either/or type** (**Answer all questions not exceeding 200 words each**. (3 x 6 = 18) Q.No. 15 – K3 level Q.No. 16 – K4 level Q.No. 17 – K5/K6 level	**18**
SECTION-D **Answer any TWO questions not exceeding 400 words each.** (2 x 12 = 24) Q.No. 18 – K1 level Q.No. 19 – K2 level Q.No. 20 – K4 level	**24**
Tota	**60**

QUESTION PATTERN FOR SUMMATIVE EXAMINATIONS

For those who join in June 2022

UG and PG

(Language Courses, Core Courses, Discipline Specific Electives, Generic Elective Courses, Non-Major Electives(PG))

DURATION:3HRS			**MAXMARKS:75**			
K-LEVELS / SECTIONS	**K1**	**K2**	**K3**	**K4**	**K5/K6**	**TOTAL MARKS**
SECTION A (Answer all questions, each question carries One Mark)	5	5				**10**
SECTION B (Answer all questions, each question carries TWO Marks, ONE question from Each unit)		4	2	2	2	**10**
SECTION C (Answer all questions-Either/or type-ONE Question from each unit)	5	10	5	5		**25**
SECTION D (Answer any THREE questions, ONE question from each unit, each question carries TEN Marks)	10	10	10	10	10	**30**
TOTAL	20	29	17	17	12	**75**

QUESTION PATTERN FOR SUMMATIVE EXAMINATIONS For those who join in June 2022 UG and PG (Skill Enhancement Courses, Self Learning Courses, Non Major Electives (UG)and Part V Courses (except NCC))						
DURATION:2HRS						**MAX MARKS:50**
K-LEVELS / SECTIONS	**K1**	**K2**	**K3**	**K4**	**K5/K6**	**TOTAL MARKS**
SECTION A (Answer all questions, each question carries One Mark)	5	5				**10**
SECTION B (Answer all questions, each question carries TWO Marks, ONE question from Each unit)	2	2	2	2	2	**10**
SECTION C (Answer any THREE questions, ONE question from each unit, each question carries TEN Marks)	10	10	10	10	10	**30**
TOTAL	17	17	12	12	12	**50**

BLUE PRINT OF QUESTION PAPER FOR INTERNAL ASSESSMENT (CIA)						
DURATION:2HRS			**MAX MARKS:60**			
K-LEVELS / SECTIONS	**K1**	**K2**	**K3**	**K4**	**K5/K6**	**TOTAL MARKS**
SECTION A (Answer all question. Each question Carries **ONE** Mark)	5	5				**10**
SECTION B (Answer all questions. Each question carries **TWO** Marks)		2	4		2	**8**
SECTION C (Answer all questions- Either/or type -Each question carries **SIX** Marks)			6	6	6	**18**
SECTION D (Answer any TWO questions. Each question carries **TWELVE** Marks)	12	12		12		**24**
TOTAL	17	19	10	18	8	**60**

VALUATION

1. Central valuation system is adopted.
2. Single Valuation system is followed for UG, PG and M.Phil. theory examinations. The valuation is done by the external examiners only.
3. UG and PG Practical Examinations are valued by both Internal and External Examiners.
4. Any discrepancy in the question paper should be brought to the notice of the Controller of Examinations by the respective Course Teacher through the Head of the Department within five days from the date of examination.

DECLARATION OF RESULTS

1. The total credit should not exceed 140 for UG Programmes and 90 for PG Programmes, excluding the credits earned for additional credit courses. This is applicable to the students migrating from other colleges also.
2. The students migrating from other colleges have to appear for the Summative Examinations conducted by the college for non-equivalent theory and practical courses. Mark scored by such a student in the Summative Examinations conducted by the previous college shall be converted to 100 if it is less than 100 for any equivalent course.
3. The students who repeat the semester have to appear not only for Summative Examinations but also for internal tests. The Internal marks scored by such students in their previous attempts shall stand invalid.
4. Results will be published within 20 days from the date of completion of all the Examinations.
5. Results will be declared as per the norms given in the following table in consultation with the Awards Committee.

Maximum and Passing Minimum Marks

Course	External Exam (SE)		Aggregate Marks (CIA + SE)	
	Passing Minimum	**Maximum Mark**	**Passing Minimum**	**Maximum Mark**
UG (Theory)	27	75	40	100
UG – NME / SEC / Part V (except NCC)	18	50 (converted to 75 marks)	40	100
UG – SLC	20	50	40	100
UG (Practicals)	21	60	40	100
UG Project	18	50	40	100
PG (Theory)	34	75	50	100
PG (Practicals)	27	60	50	100
PG (Project)	23	50	50	100
M.Phil. (Theory)	34	75	50	100
M.Phil. Project				
1. Dissertation	50	**100** (Internal 50 + External 50)	-	-
2. Viva – Voce	50	**100** (Internal 50 + External 50)	-	-

REVALUATION AND SUPPLEMENTARY EXAMINATIONS

1. Students can apply for Revaluation within 10 days from the date of the publication of the results.
2. Final year students of UG and PG Programmes can appear for Supplementary Examinations for the arrear papers of only the V and VI Semesters of UG Programmes and III and IV Semesters of PG Programmes. Students having the maximum of three arrear papers alone are eligible for Supplementary Examinations.
3. Absentees in the Summative Examinations are not eligible to apply for the Supplementary Examinations.
4. Supplementary Examinations will be conducted every year in the month of July.

ATTENDANCE

1. Students with the minimum of 75% of attendance (68 days out of 90 days) in a semester are permitted to appear for the summative examinations.
2. Students who do not have the minimum attendance should go for condonation.
3. Students who do not have the minimum attendance of 20 hrs for Certificate Programme and the minimum attendance of 20 hrs for each course in Diploma Programme will not be permitted to appear for the summative examinations.

The following are the regulations for grant of condonation.

Attendance	Condonation Fee	Authority to Consider	Nature of Penalty
65% - 74% (59-67 days)	Rs.500/-	Head of the Department	As decided by the HOD
50% - 64% (58-45 days)	Rs.1000/-	Principal and the Examination Committee	Application for exemption to be made on prescribed form with the specified remarks of the Principal
< 50% (Below 45 days)	To repeat the whole semester	-----	-----

EXAMINATION RULES AND REGULATIONS

1. Students without hall ticket and identity card are not permitted to appear for the examinations.
2. Possession of materials in any form for copying is strictly prohibited in the examination hall.
3. Students indulging in any form of malpractices in the examination are liable for severe punishment.
4. Students are not allowed into the examination hall after 30 minutes of the commencement of the examination.
5. Students should not write their names or any other identification marking except their register number in the answer scripts.
6. Students who have discontinued the Degree Programme are not permitted to write the summative examinations.

7. Students who have not completed the theory and practical courses during the Programme of their study are allowed to appear for the Summative Examinations in the same syllabi up to a period of three years from the year of the completion of Programme. However, after the completion of three years, they have to appear for the summative examinations for the equivalent course in the current syllabi only. The equivalence of a course is to be decided by the respective HOD, Dean, the Controller of Examinations and the Principal. This is also applicable to those students who repeat the semester.

PENAL ACTIONS FOR VARIOUS FORMS OF MALPRACTICES IN THE SUMMATIVE EXAMINATIONS

Sl. No.	Malpractice	Penal Action
1	In Possession of Materials relevant to the examination concerned	Cancellation of that particular paper.
2	Copied from materials in his/her possession	Cancellation of all papers of that semester
3	Copied from neighbours	Cancellation of all papers including arrear papers of that semester Cancellation of that particular paper of the candidate who helped for copying
4	Copied by exchanging answer script between neighbours	Cancellation of all papers of the candidates who exchanged their answer scripts
5	Misbehaviour in the	Cancellation of that particular paper

	examination hall	
6	Copying and Misbehaviour in the examination hall	Cancellation of all papers of that semester and debarring the candidate from appearing for the next semester examination.
7	Insertion of answer sheets which were previously stolen and written	Cancellation of all papers of that semester and debarring the candidate from appearing for the next semester examination.
8	Impersonation in the examination	Cancellation of all papers of that semester and recommending dismissal from the college.