DEPARTMENT OF MATHEMATICS

M. Phil Mathematics

M. Phil PROGRAMME

REVISED SYLLABUS

Loyola College (Autonomous)

Chennai- 600 034

Department of Mathematics
Loyola College, Chennai-600034

M. Phil Restructuring
2018-2019

Semester	Subject Code	Paper No	Paper Title	T/L/P	Hours	Credits
I		1	RESEARCH METHODOLOGY	T	3	3
		2	ALGEBRAAND ANALYSIS	T	6	6
II		3A	ADVANCED ASTRONOMY	T	3	3
		3B	ADVANCED NUMBER THEORYANDCRYPTOGRAPHY	T	3	3
		3C	ADVANCED GRAPH THEORY	T	3	3
		3D	DIFFERENTIAL TOPOLOGY	T	3	3
		3E	OPTIMIZATION TECHNIQUES	T	3	3
		3F	GEODESIC CONVEXITY IN GRAPHS	T	3	3
		3G	FUZZY SUBSETS AND APPLICATIONS	T	3	3

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PAPER 1:

RESEARCH METHODOLOGY

Objectives

- Students will be introduced to understand the different processes and parameters of research.
- Students will be guided to improve the quality of research report and thesis presentation.

Outcomes

- Students will be able to carry out the research problem individually in a perfect scientific method and skill in LATEX at the end of the course,.

Unit 1:

Research Definition and Formulation: Research Definition-Types of Research-Objectives and Strategies of Research-Various Steps in Research Process-Qualities of Researcher-Components of a Research Problem-Formulation of Research Problem-Research Design.

Unit 2:

Data Collection: Data Sources: Primary, Secondary and Tertiary Data-Literature Survey-Interpretation of data-Questionnaire Designing-Survey and Case Study Research-Laboratory Research-Critical Review- Data Analysis.

Unit 3:

Quantitative Methods: Probabilistic and Non-Probabilistic Sampling-Sampling Errors: Type I Error and Type II Error-Estimation-Hypothesis Testing and Applications-Standard Deviation-Normal Distribution, Properties-Correlation and Regression Analysis.

Unit 4:

Data Interpretation and Research Tools: Layout of a Research Paper-Impact Factor of Journals-Ethics in Publication-Plagiarism and Self-Plagiarism- Software for LATEX Paper Formatting-Software for Detection of Plagiarism.

Unit 5:

Research Reports: Structure and Components of Research Report-Types of Report-Mechanism of writing a report-Layout, structure and language of a typical report-Organization of the research report- Bibliography, referencing and footnotes-Thesis writing.

REFERENCES

1. C.R. Kothari, Research Methodology-Methods and Techniques, New Wiley Eastern Ltd., Delhi, 2009.
2. A.K. Jain, Ethical issues in scientific publication, Indian Journal of Orthopaedics, Vol. 44, no. 3, 235-237, 2010.
3. J. Stegmann, How to evaluate journal impact factors, Nature, Vol. 390, 550, 1997.
4. M. Roig, Plagiarism and self-plagiarism: What every author should know, BiochemiaMedica, Vol. 20, no. 3, 295-300, 2010.

PAPER 2

ALGEBRAAND ANALYSIS

Objective:

- Students will be introduced to know the advanced topics in algebra and analysis.

Outcome:

- Thestudents will be capable ofhandling theadvanced topics in algebraandanalysis.

Unit1:

Modules: Basic Definitions – Quotient Modules – Module Homomorphisms– Generation of Modules–Direct Sums –FreeModules.

Unit2:

Structure of Modules: Change of scalars– SimpleModules – Semi-simpleModules –Structure of Semi-simpleModules–Chain conditions–TheRadical.

Unit3:

AbstractIntegration: The concept of measurability – Simple functions – Elementary properties of measures – Integration of positive functions – Integration of complex functions – The role played by the setsof measure zero.

Unit4:

Elementary Properties of Holomorphic Functions: Complex differentiation – Integration over paths – The local Cauchy theorem – The power series representation – The global Cauchy theorem – The calculus ofresidues.

Unit5:

Fourier Transforms: Formal properties – The inversion theorem – The PlancheralTheorem - The BanachalgebraL^1.

BOOKS FOR STUDY:

1. Pierce R.S., ”Associative Algebras, Graduate Texts in Mathematics”, Springer Verlag, NewYork, 1982.
2. RudinW., “Real andComplexAnalysis”, TataMc-GrawHill, ThirdEdition,2006.

REFERENCES:

1. SergeLang, “Algebra”, AddissonWesley, Third Edition, 2005.
2. Paul R. Halmos, “MeasureTheory”,Springer 1974.
3. Royden,H.L., “RealAnalysis”, TheMacmillanCompany,NewYork,Third Edition,1988.
4. Elras, M. Stein and Ramishakarchi, “Complex Analysis”, Princeton University Press,2003.

GUIDE SPECIAL PAPER
PAPER 3(A)

ADVANCED ASTRONOMY

Objective:

- Students will be introduced to the concept of cosmology and stars.

Outcome:

- Students will be able to lead research in theoretical astronomy.

Unit 1:

Constellations and nomenclature of stars– The cardinal points and circles on the celestial sphere– Equatorial. ecliptic and galactic system of co-ordinates– Spherical triangle and related problems– Aspects of sky from different places on the earth– Twilight, Seasons, Sidereal, Apparent and Mean solar time and their relations– Equation of time– Ephemeris and Atomic Times– Calendar– Julian date and heliocentric correction.

Unit 2:

Utility of stellar spectrum– basic knowledge of stellar atmospheres– Binaries– variable stars– clusters– open and globular clusters– Laws of planetary motion– Motions and Distances of Stars– Statistical and moving cluster parallax.

Unit 3:

Effects of atmospheric refraction– aberration– parallax– precession– nutation and proper motion on the coordinates of stars– Reduction from apparent to mean places and vice versa.

Unit 4:

Distances of stars from the trigonometric– secularand moving cluster parallaxes– Stellar motions– Magnitude scale and magnitude systems– Atmospheric extinction– Absolute magnitudes and distance modulus– color index– Black-body approximation to the continuous radiation and temperatures of stars– Variable stars as distance indicators.

Unit 5:

Visual– spectroscopic and eclipsing binaries– Importance of binary stars as source of basic astrophysical data– Classification and properties of various types of intrinsic and eruptive variable stars– Astrophysical importance of the study of variable stars– Novae and Supernovae.

Books for Study:

1. Harwit, M. Astrophysical Concepts, 3rd ed, Springer-verlag, 2006.
2. K.D.Abhyankar: Astrophysics:Stars and Galaxies.Tata McGraw Hill Publication (Chap.2)
3. Padmanabhan, T., Theoretical Astrophysics, Vols.1-3, Cambridge University Press, 2005.

References:

1. W.M.Smart: Text book of Spherical Astronomy.
2. A.E.Roy: Orbital Motion.
3. McCusky: Introduction to Celestial Mechanics.
4. K.D.Abhyankar: Astrophysics:Stars and Galaxies.Tata McGraw Hill Publication (Chap.2)
5. G.Abell: Exploration of the Universe.
6. A.Unsold: New Cosmos.
7. BaidyanathBasu: Introduction to Astrophysics.

GUIDE SPECIAL PAPER
PAPER 3(B)

ADVANCEDNUMBER THEORYANDCRYPTOGRAPHY

Objective:

- Students will be introduced to know thefundamentalsofnumbertheoryandcryptographysuchascongruence's, residues andpartitions.

Outcome:

- Students will be able to understand and apply the concepts in solving problems of cryptosystems.

Unit1:

CONGRUENCES: Congruences– Solutionsofcongruences– congruencesofdeg1– The function0(n)– Congruencesof higherdegree– Prime powermoduli– Prime modulus– congruencesofdegree2– Prime modulus– Power residues.

Unit2:

QUADRATIC RESIDUES: Quadraticresidues– Quadraticreciprocity– TheJacobisymbol– greatestintegerfunction– arithmetic function– TheMobius Inversionformula– Themultiplication ofarithmeticfunctions.

Unit3:

DIOPHANTINE EQUATIONS: Diophantine equations– The equationax+by= c– Positive solutions– Other linearEquations– Sumsof four andfive squares– Waringsproblem– sumof fourthpowers– Sumof two Squares.

Unit4:

TRADITION SYMMETRIC–KEY CIPHERS: SubstitutionCiphers–TransportationCiphers– SteamandBlockCiphers–ModernBlockCiphers–ModernSteamCiphers– DES–AES.

Unit5:

ASYMMETRIC KEY CRYPTOGRAPHY: RSA Cryptosystem– Rabin Cryptosystem– ElgamalCryptosystem– EllipticCurve Cryptosystem.

BOOKS FOR STUDY:

1. IvanNiven,HerbertS.Zuckermann,HughL.Montgomery,"AnIntroductiontoTheTheoryofNumbers ", JohnWiley,Fifth Edition, 2006.
2. BehrouzA.Forouzan,"Cryptography&NetworkSecurity",TataMcGrawHill,SpecialIndianEdition, 2007.

REFERENCES:

1. TomM.Apostol, "Introduction toanalyticnumber theory",NarosaPublishingHouse, 1980.
2. RoseH.E., "A Course inNumber Theory", Clarendon Press,SecondEdition,1995.
3. KennethIreland&MichaelRosen,"AClassicalIntroductiontoModernNumber Theory",SpringerInternational Edition, Second Edition,2010.
4. Koblitz,N., "Acourse innumber theoryandCryptography",Springer Verlag,1994.
5. Stinson D.R., "Cryptography: TheoryandPractice",CRC Press,Third Edition,2002.

GUIDE SPECIAL PAPER
PAPER 3(C)

ADVANCED GRAPHTHEORY

Objective:

- Students will be introducedadvancedtopicsin graphtheory.

Outcome:

- Studentswill beable topursueresearch infrontierareasof graphtheory.

Unit1:

CONNECTIVITY IN GRAPHS: Vertexconnectivity–Edgeconnectivity–Blocks–k-connectedandk-edgeconnectedgraphs–Networkflowproblems.

Unit2:

COLORING OFGRAPHS: Vertexcoloringsandupperbounds–Brooks'theorem–Graphswithlargechromaticnumber– Turan's theorem– Countingpropercolorings– Edgecolouring–Characterization oflinegraphs.

Unit3:

PLANAR GRAPHS: EmbeddingsandEuler'sformula–Dualgraphs–Kuratowski'stheorem –5colourtheorem–Crossingnumber– Surfaceofhigher genus.

Unit4:

RAMSEYTHEORY: Thepigeonhole principle–Ramsey's theorem–Ramseynumbers–GraphRamseytheory.

Unit5:

EIGENVALUES OF GRAPHS: Thecharacteristicpolynomial–Linearalgebraofrealsymmetricmatrices–Eigenvaluesandgraph parameters –Eigenvaluesofregulargraphs– Stronglyregulargraphs.

BOOKS FOR STUDY:

1. Douglas B. West, "Introduction to Graph Theory", Prentice Hall of India, Second Edition,2002.

REFERENCES:

1. BondyJ.A,andMurty U.S. R., "GraphTheory",Springer, 2008.
2. Balakrishnan R. andRanganathanK., " Atextbook ofGraphTheory", Springer,2012.
3. Graham R.L., Rothschild B.L and Spencer J.H., "Ramsey Theory", Wiley Publishers,SecondEdition, 1990.
4. Biggs N., "Algebraic Graph Theory", Cambridge Tracts in Mathematics 67, CambridgeUniversity Press,1994**.**

GUIDE SPECIAL PAPER
PAPER 3(D)

DIFFERENTIAL TOPOLOGY

Objective:

- Students will be introducedthenotionofsmoothmanifoldsandclassifycompactonemanifoldsandsmooth compactsurfaces.

Outcome:

- Students will be able to solve the problems in differential manifolds occur in different fields like mathematics, physics, mechanics and economics.

Unit1:

MANIFOLDSAND MAPS: Derivatives and tangents–inverse function theorem and immersions–submersions–homotopyand stability–Sard's theoremand Morsefunctions–embedding manifoldsinEuclideanspace.

Unit2:

TRANSVERSALITYAND INTERSECTION: Manifoldswithboundary–onemanifoldsandsomeconsequences–transversality–intersectiontheory modulo 2–windingnumbersandtheJordan–Brouwerseparationtheorem.

Unit3:

ORIENTED INTERSECTIONTHEORY: Orientationonmanifolds–orientedintersectionnumber–degreesofmaps–fundamentaltheoremof algebra–Eulercharacteristicasanintersectionnumber.

Unit4:

APPLICATIONS OF INTERSECTION THEORY: LefschetzFixedpointtheory – BorsukUlamtheorem –vector fields-isotopy-Hopfdegreetheorem.

Unit5:

COMPACTSMOOTH SURFACES: Morsefunctions–MorseLemma–Connectedsum–Attachinghandles–Handledecompositiontheorem–Application to smooth classificationofcompactsmoothsurfaces.

BOOKS FOR STUDY:

1. GuilleminV. and PollackA., "DifferentialTopology",Prentice-Hall,1974.
2. MorrisW.Hirsch, "Differential topology",Springer-Verlag,1976.

REFERENCES:

1. Milnor J., "Topology from the differentiable viewpoint, Princeton Landmarks inMathematics", PrincetonUniversity Press, 1997.
2. ShastriA.R., "ElementsofDifferentialTopology",CRC Press,2011.

GUIDE SPECIAL PAPER
PAPER 3(E)

OPTIMIZATION TECHNIQUES

Objective:

- Students will be introduced to various operationsresearchtoolsindecision makingin anorganization.

Learning outcome:

- Studentswillbecapableofusingadvancedtechniquesinvariousoperations researchtoolsindecision makingandable to formulateorganizationproblemsinto operations researchmodels forseekingoptimal solutions.

Unit1:

ADVANCED LINEAR PROGRAMMINGAND GOAL PROGRAMMING: Revised simplex algorithm –Dantzig _ Wolfedecompositionalgorithm– Karmarkarinterior _pointalgorithm–Goal programming algorithms.

Unit2:

HEURISTIC PROGRAMMING: GreedyHeuristics: Discretevariableheuristic– Continuousvariableheuristic–Metaheuristic:Tabu searchalgorithm–Simulated annealingalgorithm –Genetic algorithm.

Unit3:

DECISION ANALYSIS: Decision making under certainty-Hierarchy process- Decision making under risk- Decision tree based expected value criterion- Variants of the expected value criterion- Decision making under uncertainty.

Unit 4:

NON-LINEAR PROGRAMMING: Unconstrainedalgorithms:Directsearch method– Gradiantmethod –Constrainedalgorithms: Separableprogramming, Chance– constrainedprogramming.

Unit 5:

SIMULATION: Natureandneed for simulation-Monte-Carlosimulation– Generationofpseudorandomnumbersby mid-square method,Congruencemultipliermethod–Testforrandomness–Generatingrandom variatesforUniform,Exponential,Erlangian,Poisson,Normaldistributions-Applicationsto simple problemsinoperationsresearch.

BOOKS FOR STUDY:

1. HamdyA.Taha,"OperationsResearch-AnIntroduction",PearsonEducation,NewDelhi, Tenth Edition,2018.
2. GeoffreyGordon, "SystemSimulation", PearsonEducation,NewDelhi,Second Edition, 2017.

REFERENCES:

1. Harvey M. Wagner, "Principles of Operations Research with Applications to Managerial

Decisions",Prentice-Hall ofIndia Pvt. Ltd.,NewDelhi,SecondEdition, 1975.
2. RaoS.S.,"EngineeringOptimization:TheoryandPractice",WileyandNewAgeInternational, FourthEdition,2009.
3. Sharma J K .,"Operations Research", Trinity Press, New Delhi,SixthEdition, 2017.

GUIDE SPECIAL PAPER
PAPER 3(F)

GEODESIC CONVEXITY IN GRAPHS

Objective:

- Students will be introduced to the geodesic convexity ideas in graph theory and real life problem.

Learning outcome:

- The students will be able to apply geodesic convexity concepts in artificial intelligence, parallel interconnection network etc.,

Unit 1:

Introduction-Graph Theory- Metric Graph Theory-Convexity Spaces-Graph Convexities.

Unit 2:

Invariants-Geodetic Closure And Convex Hull-Geodetic And Hull Numbers-Monophonic And M-Hull Numbers-Convexity Number-Forcing Geodomination

Unit 3:

Closed Geodomination-Geodetic Domination-K-Geodomination-Edge Geodomination-Classical Parameters.

Unit 4:

Graph Operations-Cartesian Product-Strong Product-Lexicographic Product-Join-Corona Product.

Unit 5:

Oriented Graphs-Computational Complexity

Text Book:

Geodetic Convexity In Graphs- Ignaciom.Pelayo-Springer.

GUIDE SPECIAL PAPER
PAPER 3(G)

FUZZY SUBSETS AND ITS APPLICATIONS

Objectives:

- Students will able to understand the mathematical concepts that help in analyzing the uncertain situations.
- Students will able to congnize mathematical tools to apply to real life situations.

Learning outcomes:

- Students will be able to get a deeper analysis on how mathematical concepts are extended into fuzzy world of uncertainties.
- Students will be able to equip themselves with fuzzy theoretical tools and also application nuances.

Unit 1:

Introduction – Characteristic Function – Membership Function – Characteristics and significance of the paradigm shift – The concept of a fuzzy subset –Crisp set vs fuzzy subsets – Operations on fuzzy subsets – Properties of the set of the fuzzy subsets – Types of fuzzy sets – Extension principle.

Unit 2:

Berge graph – Fuzzy graphs – Fuzzy relations – Fuzzy subsets induced by a mapping – Conditioned fuzzy subsets – Properties of fuzzy binary relation – Transitive closure of a fuzzy binary relation – Fuzzy preorder relations – Similitude relations – Similitude sub relations in a fuzzy preorder – Antisymmetry – Fuzzy order relations – Ordinal relations – Dissimilitude relations – Resemblance relations – Dissemblance relation.

Unit 3:

Classical logic – Multivalued logic – Fuzzy logic – Truth tables and linguistic approximation – Linguistic variables – Linguistic hedges – Fuzzy propositions – Types of fuzzy propositions – Fuzzy quantifiers – Fuzzy inference rules – Fuzzy control system.

Unit 4:

Fuzzy arithmetic – Interval of confidence – Fuzzy numbers – Operations on fuzzy numbers – Maximum and minimum of fuzzy numbers – L-R fuzzy number – Triangular fuzzy number – Trapezoidal fuzzy number –Quadrilateral fuzzy number - Pentagonal fuzzy number – Operations on triangular, trapezoidal and pentagonal fuzzy numbers – Interval of confidence with fuzzy numbers of type-2 – Functions of fuzzy numbers – Derivative of a function of fuzzy numbers.

Unit 5:

Decisions – Fuzzy Decisions – Individual decision making – Group or Multiperson decision making – Fuzzy multi criteria decision making – Fuzzy multi objective decision making – Fuzzy multi attribute decision making – Fuzzy analytic hierarchy process – Fuzzy TOPSIS – Applications in medicine, socio-economic studies, genetics – engineering and robotics.

Text Book:

1. A. Kaufmann, Introduction to the Theory of Fuzzy Subsets – Volume 1, Academic Press, New York, 1975.
   [Chapter: Sections 1 – 8, 10 - 26]
2. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall of India, New Delhi, 2002.
   [Chapter: 8; Sections 8.1 – 8.8, Chapter: 15; Sections 15.1-15.4]
3. A. Kaufmann and M. M. Gupta, Introduction to Fuzzy Arithmetic: Theory and Applications, International Thomson Computer Press, Boston, U.S.A, 1991.
   [Chapter: 1; Sections 1.1 – 1.6, 1.9-1.10, Chapter: 2; Sections 2.7, Chapter: 3; Sections 3.6-3.7]
4. H. J. Zimmermann, Fuzzy Set Theory and its Applications, Kluwer Academic Publishers, The Netherlands, 1992.
   [Chapter: 3; Sections 3.1, Chapter: 5; Sections 5.1, Chapter: 9; Sections 9.1-9.2, Chapter: 12; Sections 12.1, 12.4]
5. A. Emrouznejad and William Ho, Fuzzy Analytic Hierarchy Process, CRC Press, Taylor & Francis Group, Boca Raton, FL, 2018.
   [Chapter: 1, 2, 6]

References:

1. Lotfi A. Zadeh, Fuzzy Sets and their Applications to Cognitive and Decision Processes, Academic Press, New York, 1975.
2. Bart Kosko, Neural Networks and Fuzzy Systems, Prentice-Hall of India, New Delhi, 2003.
3. T. L. Saaty and L. G. Vargas, Models, Methods, Concepts & Applications of the Analytic Hierarchy Process, Springer Science+Business Media, LLC, New York, 2001.
4. Ching-Lai Hwang and Kwangsun Yoon, Multiple Attribute Decision Making: Methods and Applications, Springer-Verlag, Berlin Heidelberg, 1981.

GUIDE SPECIAL PAPER
PAPER 3(H)

FUZZY LOGIC AND ITS APPLICATIONS

Objectives:
Students will be able to

- Fundamentals of fuzzy logic
- Concepts of fuzzy sets, knowledge representation using fuzzy rules, fuzzy logic, fuzzy prepositions and fuzzy quantifiers and applications of fuzzy logic.
- Conceptualize the principle, formulation and computational procedure of fuzzy logic
- Recognize fuzzy logic membership function and fuzzy inference systems.
- Make applications on Fuzzy logic membership function and fuzzy inference systems.

COURSE OUTCOMES:

CO1: familiarizing the basic of fuzzy concepts
CO2: exploring the techniques involved in fuzzy logic.
CO3: enhancing the skill of artificial neural network
CO4: Explore the functional components of of fuzzy logic classification on controller.
CO5: Develop and implement a basic trainable fuzzy logic system to design and manufacturing.

UNIT I : INTRODUCTION TO FUZZY LOGIC PRINCIPLES

Basic concepts of fuzzy set theory – operations of fuzzy sets – properties of fuzzy sets – Crisp relations – Fuzzy relational equations – operations on fuzzy relations – fuzzy systems – propositional logic – Inference – Predicate Logic – Inference in predicate logic – fuzzy logic principles – fuzzy quantifiers – fuzzy inference – fuzzy rule based systems – fuzzification and defuzzification – types.

UNIT II : ADVANCED FUZZY LOGIC APPLICATIONS

Fuzzy logic controllers – principles – review of control systems theory – various industrial applications of FLC adaptive fuzzy systems – fuzzy decision making – Multiobjective decision making – fuzzy classification – means clustering – fuzzy pattern recognition – image processing applications – systactic recognition – fuzzy optimization.

UNIT III : INTRODUCTION TO ARTIFICIAL NEURAL NETWORKS

Fundamentals of neural networks – model of an artificial neuron – neural network architectures – Learning methods – Taxonomy of Neural network architectures – Standard back propagation algorithms – selection of various parameters – variations Applications of back propagation algorithms.

UNIT IV : OTHER ANN ARCHITECTURES

Associative memory – exponential BAM – Associative memory for real coded pattern pairs – Applications adaptive reasonance theory – introduction – ART 1 – ART2 – Applications – neural networks based on competition – kohenenself organizing maps – learning vector quantization – counter propagation networks – industrial applications.

UNIT V : RECENT ADVANCES

Fundamentals of genetic algorithms – genetic modeling – hybrid systems – integration of fuzzy logic, neural networks and genetic algorithms – non traditional optimization techniques like ant colony optimization – Particle swarm optimization and artificial immune systems – applications in design and manufacturing.

TEXT BOOKS:

- Klir.G, Yuan B.B. "Fuzzy sets and Fuzzy Logic Prentice Hall of India private limited, 1997.
- LauranceFausett, "Fundamentals of Neural Networks", Prentice hall, 1992
- Rajasekaran. S..VijayalakshmiPai. G.A. "Neural Networks, Fuzzy Logic and Genetic Algorithms", Prentice Hall of India Private Limited, 2003
- Timothy J.Ross, "Fuzzy logic with Engineering Applications", McGraw Hill, 1995

REFERENCES:

- Gen, M. and Cheng R. "Genetic Algorithm and Engineering Design", john wiley 1997
- Zurada J.M. "Introduction to Artificial Neural Systems", Jaico publishing house, 1994.