ALAGAPPA UNIVERSITY

(A State University Established in 1985)

Karaikudi - 630003. Tamil Nadu, India

2017 Accredited with A+ Grade by NAAC (CGPA : 3.64)

2018 MHRD Govt. of India UGC Graded as Category - I Granted Autonomy

2018 MHRD Swachh Campus Rank : 4

2021 nirf National Institutional Ranking Framework Rank : 33

2021 QS University Rankings Asia Rank : 199

FACULTY OF SCIENCE

DEPARTMENT OF MATHEMATICS

M.Phil., MATHEMATICS

REGULATIONS AND SYLLABUS

(For the candidates admitted from the Academic Year 2022 - 2023)

DEPARTMENT OF MATHEMATICS

M.PHIL. MATHEMATICS

REGULATIONS AND SYLLABUS

[For the candidates admitted from the Academic Year 2022 – 2023 onwards]

ALAGAPPA UNIVERSITY

(A State University Accredited with "A+" grade by NAAC (CGPA: 3.64) in the Third Cycle andGraded as Category-I University by MHRD-UGC)

Karaikudi - 630003, Tamil Nadu

Panel of Members-Broad Based Board of Studies

Chairperson

Dr. N. Anbazhagan, Professor & Head, Department of Mathematics, Alagappa University, Karaikudi. Teaching Experience: 20 years, Research experience: 20 years, Area of Research: Stochastic Modeling, Data mining.

Foreign Experts

Dr. Rozaini Roslan, Professor, Department of Mathematics & Statistics,Faculty of Applied Sciences and Technology,Universiti Tun Hussein Onn Malaysia,Pagoh, Muar 84600, Malaysia., rozaini@uthm.edu.my . Working Experience: 20 Years, Research Experience: 20 Years, Area of Research: Fluid Mechanics, Heat and Mass Transfer, Nanofluids

Indian Experts

Dr. R. Uthayakumar, Professor and Head, Department of Mathematics, Gandhigram Rural Institute,Dindugal Teaching Experience: 24 years, Research experience: 24 Years, Area of Research: Fractal Theory, Operations Research, Inventory Management and Control

Dr. S. Muralisankar, Professor, Department of Mathematics, Madurai Kamaraj University, Madurai. Teaching Experience: 18 Years, Research experience: 18 Years, Area of Research: Fixed Point Theory,Fuzzy Functional Differential Equations, Stability analysis of Dynamical Systems

Members

Dr. J. Vimala, Assistant Professor, Department of Mathematics, Alagappa University, Karaikudi. Teaching Experience: 18 years, Research Experience: 15 years, Area of Research: Algebra –Lattice Theory, Fuzzy Algebra, Decision Theory and Soft computing.

Dr. R. Raja, Assistant Professor, Ramanujan Centre for Higher Mathematics, Alagappa University, Karaikudi. Teaching Experience: 11 Years, Research Experience: 10 years, Area of Research: Abstract & Fractional Differential Equations, Stability Analysis of Dynamical Systems, Neural Networks, Synchronization Theory, Mathematical Modeling and Population Systems, Genetic Regulatory Networks, Complex Dynamical Networks and Multi-Agent Systems.

Dr. B. Sundaravadivoo, Assistant Professor, Department of Mathematics, Alagappa University, Karaikudi. Teaching Experience: 19 years, Research Experience: 4 year, Area of Research: Abstract & Fractional Differential Equations, Control Theory, Mathematical Modelling and Perturbation Theory, Optimal Control.

Dr. S. Amutha, Assistant Professor, Ramanujan Centre for Higher Mathematics, Alagappa University, Karaikudi. Teaching Experience: 13 years, Research Experience: 13 years, Area of Research: Graph Theory, Domination Theory, Algorithmic Graph theory, Discrete Mathematics, Cryptography.

Dr. R. Jeyabalan, Assistant Professor, Department of Mathematics, Alagappa University, Karaikudi. Teaching Experience: 7 years, Research Experience: 7 years, Area of Research: Magic Labeling Graph Theory, Fuzzy Topology and Fuzzy Magic Labeling Graph Theory.

Dr. M. Mullai, Assistant Professor, Directorate of Distance Education, Alagappa University, Karaikudi. Teaching Experience: 18 years, Research Experience: 15 years, Area of Research: Algebra & Fuzzy Algebra, Operations Research, Mathematical Modelling, Neutrosophic sets (Neutrosophic Inventory, Neutrosophic Graph theory, Neutrosophic Optimization, Neutrosophic Adhoc networks)

Co opted Member from the Industry:

Mr. S. Gnanapandithan, Senior Manager ,Cognizant Technology Solutions, Coimbature, Robotic Process Automation Architect.

Alumni

Dr. A. Tamilselvan, Professor & Head, Department of Mathematics, Bharathidasan University, Tirchirapalli. Teaching Experience: 21 years, Research Experience: 21 years, Area of Research: Differential Equations, Numerical Analysis, Fractional Differential Equations, Finite Difference Methods, Finite Volume Methods.

Ex-officio Member

Dr. V.Sivakumar, Professor and Co-ordinator, Curriculum Development Cell, Distance Education, Alagappa University, Karaikudi Teaching Experience: 24 years, Research Experience: 17 years, Area of Research: Marketing Management , Agricultural Marketing , International Logistics , Agricultural Logistics and SCM , Consumer Research.

ALAGAPPA UNIVERSITY

DEPARTMENT OF MATHEMATICS

Karaikudi -630003, Tamil Nadu.

REGULATIONS AND SYLLABUS-(CBCS-University Department)

[For the candidates admitted from the Academic Year 2022 – 2023 onwards]

Name of the Department: **Department of Mathematics**

Name of the Subject Discipline: **Mathematics**

Programme of Level: **M.Phil.**

Duration for the Course: **Full Time** (One Year)

1. Choice-Based Credit System

A choice-Based Credit System is a flexible system of learning. This system allows students to gain knowledge at their own tempo. Students shall decide on electives from a wide range of elective courses offered by the University Departments in consultation with the Department committee. Students undergo additional courses and acquire more than the required number of credits. They can also adopt an inter-disciplinary and intra-disciplinary approach to learning, and make the best use of the expertise of available faculty.

2. Programme

"Programme" means a course of study leading to the award of a degree in a discipline.

3. Courses

'Course' is a component (a paper) of a programme. Each course offered by the Department is identified by a unique course code. A course contains lectures/ tutorials/laboratory /seminar /project /practical training/report writing /Viva-voce, etc or a combination of these, to meet effectively the teaching and learning needs.

4. Credits

The term "Credit" refers to the weightage given to a course, usually in relation to the instructional hours assigned to it. Normally in each of the courses credits will be assigned on the basis of the number of lectures/tutorial/laboratory and other forms of learning required to complete the course contents in a 15-week schedule. One credit is equal to one hour of lecture per week. For laboratory/field work one credit is equal to two hours.

5. Semesters

An Academic year is divided into two **Semesters.** In each semester, courses are offered in 15 teaching weeks and the remaining 5 weeks are to be utilized for conduct of examination and evaluation purposes. Each week has 30 working hours spread over 5 days a week.

6. Departmental committee

The Departmental Committee consists of the faculty of the Department. The Departmental Committee shall be responsible for admission to all the programmes offered by the Department including the conduct of entrance tests, verification of records, admission, and evaluation. The Departmental Committee determines the deliberation of courses and specifies the allocation of credits semester-wise and course-wise. For each course, it will also identify the number of credits for lectures, tutorials, practicals, seminars etc. The courses (Core/Discipline Specific Elective/Non-Major Elective) are designed by teachers and approved by the Departmental Committees. Courses approved by the Departmental Committees shall be approved by the Board of Studies/Broad Based Board of Studies. A teacher offering a course will also be responsible for maintaining attendance and performance sheets (CIA -I, CIA-II, assignments and seminar) of all the students registered for the course. The Non-major elective programme, MOOCs coordinator and Internship Mentor are responsible for submitting the performance sheet to the Head of the department. The Head of the Department consolidates all such performance sheets of courses pertaining to the programmes offered by the department. Then forward the same to be Controller of Examinations.

7. Programme General Objectives- (PGO) Minimum 6 objectives are required

PGO-1	To apply precise, logical reasoning to problem solving.
PGO-2	To provide comprehensive curriculum to groom the students.
PGO-3	To inculcate innovative skills, team work, ethical practices to face the society.
PGO-4	To stimulate the students for future research.
PGO-5	To identify the challenging problems and find solutions.
PGO-6	To develop a multi-disciplinary approach for solving problems through core courses.

8. Programme Specific Objectives-(PSO)- Minimum 6 objectives are required

PSO-1	To provide the student with pertinent information in the field of Mathematics.
PSO-2	To teach the student with a broad understanding of Mathematical and their interactions with the Equations.
PSO-3	To include methods of facilitating learning such as projects, group work and participative learning
PSO-4	To establish inter-disciplinarily between Mathematics and other subjects from Humanities and the Social Sciences.
PSO-5	To learn to apply Mathematics to real life situations and help in problem solving.
PSO-6	To qualify national level competitive exams like CSIR-NET/GATE etc.

9. Programme Outcome-(PO) - Minimum 6 objectives are required

PO-1	The students will learn to solve advanced mathematical equations theoretically/MATLAB.
PO-2	The students will know the concept of topological vector space and separation properties.
PO-3	The students will learn the fundamentals of carrying out a research as well as how to plan lessons, carry them out, and analyze the findings.
PO-4	The students will be able to acquire knowledge of product measures, Convolution and Distribution functions.
PO-5	The students will be able to develop their research abilities and master the most cutting-edge developments in mathematics.
PO-6	The students will be able to identify different sorts of research, its goals, write a thesis, and create a mathematical document in Latex.

10. Eligibility for admission

A candidate who has passed the undergraduate course like M.Sc., Mathematics / M.Sc., Mathematics (Computer Applications) degree of this University or any of the above degree of any other University shall be eligible for admission in Master of Philosophy (M.Phil.,) Degree in Mathematics of this University.

11. Medium of Instruction

English

12. Minimum Duration of programme

The programme is for a period of one year. Each year shall consist of two semesters viz. Odd and Even semesters. Odd semesters shall be from June / July to October / November and even semesters shall be from November / December to April / May. Each Semester there shall be 90 working days consisting of 6 teaching hours per working day (5 days/week).

- **Plan of work**

The candidate shall undergo Dissertation Work during the fourth semester. The candidate shouldprepare a scheme of work for the dissertation and should get approval from the guide. The candidate, after completing the dissertation work, shall be allowed to submit to the university at the end of the fourth semester. If the candidate is desirous of availing the facility from other universities/laboratory, they will be permitted only after getting approval from the guide. In such case, the candidate shall acknowledge the same in their dissertation.

Project/Dissertation

The candidate shall undergo Project/Dissertation Work during the final semester. The candidate should prepare a scheme of work for the dissertation/project and should get approval from the guide. The candidate, after completing the dissertation /project work, shall be allowed to submit it to the university departments at the end of the final semester. If the candidate is desirous of availing the facility from other departments/universities/laboratories/organizations they will be permitted only after getting approval from the guide and HOD. In such a case, the candidate shall acknowledge the same in their dissertation/project work.

Format to be followed for dissertation/project report

The format /certificate for thesis to be followed by the student are given below

- Title page
- Certificate
- Acknowledgment
- Content as follows:

Chapter No	Title	Page number
1	Introduction	
2	Aim and objectives	
3	Review of literature	
4	Materials and methods	
5	Result	
6	Discussion	
7	Summary	
8	References	

Format of the title page

Title of Dissertation/Project work

Dissertation/Project submitted in partial fulfilment of the requirement for the degree of Master of Science to the Alagappa University, Karaikudi -630003.

By

(Student Name)

(Register Number)

University Logo

Department of ----------

Alagappa University

(A State University Accredited with "A+" grade by NAAC (CGPA: 3.64) in the ThirdCycleand Graded as Category-I University by MHRD-UGC, 2019: QS ASIA Rank-216, QS BRICS Rank-104,QS India Rank-20)

Karaikudi - 630003

(Year)

- **Format of certificates**

Certificate -Guide

This is to certify that the **Dissertation/Project** entitled "----------" submitted to Alagappa University, Karaikudi-630 003 in partial fulfilment for the degree of Master of Science in ---------- by Mr/Mrs ----------(Reg No----------) under my supervision. This is based on the results of studies carried out by him/her in the Department of----------, Alagappa University, Karaikudi-630 003. This Dissertation/Project or any part of this work has not been submitted elsewhere for any other degree, diploma, fellowship, or any other similar titles or record of any University or Institution.

Research Supervisor

Place:Karaikudi
Date:_____

Certificate - (HOD)

This is to certify that the thesis entitled **" ----------"** submitted by Mr/Mis ----------(Reg No: ----------) to the Alagappa University, in partial fulfilment for the award of the degree of Master of --------in ---------- is a bonafide record of research work done under the supervision of Dr.----------, AssistantProfessor, Department of----------, Alagappa University. This is to further certify that the thesis or any part thereof has not formed the basis of the award to the student of any degree, diploma, fellowship, or any other similar title of any University or Institution.

Place: Karaikudi Head of the Department

Date:_____

Declaration (student)

I hereby declare that the dissertation entitled **" ----------"** submitted to the Alagappa University for the award of the degree of Master of -------- in ---------- has been carried out by me under the guidance of Dr. **----------**, Assistant Professor, Department of ----------, Alagappa University, Karaikudi – 630 003. This is my original and independent work and has not previously formed the basis of the award of any degree, diploma, associateship, fellowship, or any other similar title of any University or Institution.

Place: Karaikudi (_____)

Date:_____

Internship

The students shall undergo Internship / industrial training in the reputed organizations for minimum of two weeks to acquire industrial knowledge during the summer vacation of second semester. The students have to find industry related to their discipline (Public limited/Private Limited/owner/NGOs etc.,) in consultation with the faculty in charge/Mentor and get approval from the Head of the Department and Departmental Committee before going for an internship / industrial training.

- **Format to be followed for Internship report**

The format /certificate for internship report to be followed by the student are given below

- Title page -**Format of the title page**

Title of internship report

Internship report submitted in partial fulfilment of the requirement for the Master of degree in ---------- to the Alagappa University, Karaikudi -630003.

By

(Student Name)

(Register Number)

University Logo

Department of ----------

Alagappa University

(A State University Accredited with "A+" grade by NAAC (CGPA: 3.64) in the ThirdCycle and Graded as Category-I University by MHRD-UGC, 2019: QS ASIA Rank- 216, QS BRICS Rank-104,QS India Rank-20)

Karaikudi – 630003

(Year)

- Certificate-(**Format of certificate – faculty in-charge)**

This is to certify that the report entitled " ---------- " submitted to Alagappa University, Karaikudi-630 003 in partial fulfilment for the Master of Science in ----------by Mr/Mis---------- (Reg No----------) under my supervision. This is based on the work carried out by him/her in the organization M/S----------. This Internship report or any part of this work has not been submitted elsewhere for any other degree, diploma, fellowship, or any other similar record of any University or Institution.

Place: Karaikudi Research Supervisor

Date:_____

Certificate (HOD)

This is to certify that the Internship report entitled **" ----------"** submitted by Mr/Mis**.----------(Reg No ----------)** to the Alagappa University, in partial fulfilment for the award of the Master of Science in-------- is a bonafide record of Internship report done under the supervision of----------, Assistant Professor, Department of---------- , Alagappa University and the work carried out by him/her in the organization M/S ----------. This is to further certify that the thesis or any part thereof has not formed the basis of the award to the student of any degree, diploma, fellowship, or any other similar title of any University or Institution.

Place: Karaikudi Head of the Department

Date:_____

- Certificate-(**Format of certificate – Company supervisor or Head of theOrganization)**

This is to certify that the Internship report entitled "----------
----" submitted to Alagappa University, Karaikudi-630 003 in partial fulfilment for the Master of Science in ----------by Mr/Mis---------- (Reg No ----------) under my supervision. This
is based on the work carried out by him/her in our organization M/S ---------
---------- for the period of three months or ------. This Internship report or any part of this work has not been submitted elsewhere for any other degree, diploma, fellowship, or any other similar record of any University or Institution.

Place: Karaikudi Supervisor in charge

Date:_____

Declaration (student)

I hereby declare that the Internship Report entitled **" ----------"** submitted to the Alagappa University for the award of the **Master of Science in ----------**has been carried out by me under the supervision of ---------- , Assistant Professor, Department of----------, Alagappa University, Karaikudi – 630 003. This is my original and independent work carried out by me in the organization M/S ---------- for the period of three months or------- and has not previously formed the basis of the award of any
degree, diploma, associateship, fellowship, or any other similar title of any University or Institution.

Place: Karaikudi (_____)

Date:_____

- Acknowledgment
- Content as follows:

Chapter No	Title	Page number
1	Introduction	
2	Aim and objectives	
3	Organisation profile /details	
4	Methods / Work	
5	Observation and knowledge gained	
6	Summary and outcome of the Internship study	
7	References	

- **No. of copies of the dissertation/internship report**

The candidate should prepare three copies of the dissertation report and submit the same for the evaluation of examiners. After evaluation, one copy will be retained in the department library, one copy will be retained by the guide and the student shall hold one copy. The candidate should prepare one copy of the field visit/internship report and submit the same for the evaluation of examiners.

13. Teaching methods

The method of teaching is by giving lectures, tutorials, seminars and supervised research projects. Moreover, extensive use is made of IT and a wide range of materials is available to enable students to study at their own place and in their own time to enhance and extend the material taught formally.

14. Attendance

Students must have earned 75% of attendance in each course for appearing for the examination. Students who have earned 74% to 70% of attendance need to apply for condonation in the prescribed form with the prescribed fee. Students who have earned 69% to 60% of attendance need to apply for condonation in the prescribed form with the prescribed fee along with the Medical Certificate. Students who have below 60% of attendance are not eligible to appear for the End Semester Examination (ESE). They shall re- do the semester(s) after completion of the programme.

ALAGAPPA UNIVERSITY, KARAIKUDI

Choice-based Credit system (CBCS)

(For the candidates admitted from the academic year 2022-2023 onwards)

M. Phil. Mathematics

S.No.	Course Code	Name of the course	Credits	Marks		
				Int.	Ext.	Total
SEMESTER-I						
1.	571101	Research Methodology	4	25	75	100
2.	571102	Measure Theory	4	25	75	100
3.	571103	General Skills inFourier Analysis	4	25	75	100
SEMESTER-II						
4.	--	Specialization Course-I	4	25	75	100
5.	571999	Dissertation & Vivavoce	8	Viva voce (50) + Dissertation (150)		200
		Total Marks	**24**	**--**		**600**

Core Course	
Course Code	**Course Name**
571101	Research Methodology
571102	Measure Theory
571103	General Skills in Fourier Analysis
Core Course - Specialization	
Course Code	**Course Name**
571201	Functional Analysis
571202	Commutative Algebra
571203	Domination in Graphs
571204	Fractional Differential Equations

Semester – I		
Course Code: 571101	**Research Methodology**	**Credits: 4**

Objectives	➢ Understanding the problem to be studied and identifying the research methodology of therelevant research area. ➢ Studying and identifying the MATLAB Software. ➢ Acquire the knowledge of MATLAB to use in Mathematical Applications. ➢ Acquire the knowledge of Environments and document layout in Latex. ➢ Develop their skills in Latex.
Unit - I	**Research Methodology-** An Introduction-Meaning of Research - Objectives of Research - Motivationin Research - Types of Research- Research Approaches - Significance of Research - Research Methods versus Methodology - Research and Scientific Method - Importance of Knowing How Research is Done- Research Process - Criteria of Good Research.
Unit - II	**Basics of MATLAB :** MATLAB windows- online help- Input output- File types-Platform defendence- General commands-Intractive Computation: Matrics and vectors-matric and array operation-character strings-Special note on array operation-Command line Functions-using built-in functions and online-help-plating simple graphs.
Unit - III	**Applications:** Linear Algebra- curve fitting and Interpolation-Data Analysis and Statistics-Numerical Integration-Ordinary differential equations.
Unit - IV	**Commands and Environments:** Command names and arguments,-Environments-Declaration- Lengths- Special characters-Spaces and carriage returns. Document Layout and Organization: Document class,-Page style-Parts of the document-Changing font, Centering and indenting- Lists- Theorem-like declarations.
Unit - V	**Mathematical Formulae:** Mathematical environments,-Main elements of math mode-Mathematicalsymbols-Additional elements, Fine-tuning mathematics-Horizontal spacing, selecting font size in formulas-processing parts of a document, In-text references, Bibliographies.

Suggested Readings:-

Daniel T. Valentine and Brian D. Hahn(2022). *Essential MATLAB for Engineers and Scientists*, (8th ed.) Academic Press.

Gurumani, N. (2010). *Thesis Writing and Paper Presentation*. MJP Scientific Publishers.

Kopka, H., Daly, P.W. (2004). *A Guide to LATEX* (4th ed.). London: Addision–Wesley.

Kothari, C. R., (1990). *Research Methodology: Methods and Techniques* (2nd ed.). New Age International Publishers.

Rudra Pratap.(2015). *Getting Started with MATLAB.*Printed in India by Thomsan Press (India Ltd) Oxford UniversityPress.

Kottwitz, S. (2011). *Latex Beginners Guide*. Packt publishing.

Outcomes	After the successful completion of this course, the student will be able to: ➢ Review literature to understand how others have approached or dealt with the problem ➢ Learn all features of MATLAB as a programming tool. ➢ Work with a MATLAB programming. ➢ Write valid LaTeX documents that can be typeset on either a local LaTeX installation. ➢ Know various special formatting commands, including those for mathematics, text formattingand tables.

Course Designed byDr. N. Anbazhagan

Professor & Head Department of Mathematics

Semester – I		
Course Code: 571102	**Measure Theory**	**Credits: 4**
Objectives	➢ To introduce the concept of abstract measures and measure integration. ➢ To derive classical Lebesgue measure and Lebesgue integration as particular cases. ➢ introduce Lebesgue spaces L^p as normed spaces. ➢ provide representation theorems and duals of L^p spaces. ➢ derive Fubini's theorem and to introduce convolution.	
Unit - I	**Abstract Integration:** Set - Theoretic notations and terminology - The concept of measurability - Simple functions - Elementary properties of measures - Arithmetic in $[0, \infty]$ - Integration of positive measure - Integration of complex functions - The role played by sets of measurable functions.	
Unit - II	**Positive Borel Measures**: Vector spaces - Topological preliminaries - The Riesz representationtheorem - Regularity properties of Borel measures - Lebesgue measure - Continuity properties of measurable functions.	
Unit - III	**L^p spaces:** Convex functions and inequalities - The L^p spaces-Approximation by continuous functions.	
Unit - IV	**Complex Measure:** Total variations - Absolute continuity - Consequences of the Radon – Nikodym theorem - Bounded linear functionals on Lp - The Riesz representation theorem.	
Unit - V	**Integration on Product Measures:** Measurability on cartesian products-Product measures - The Fubini theorem - Completion of product measure – Convolution - Distribution functions.	
Suggested Readings:- Rudin, W. (2006). *Real and Complex Analysis* (3rd ed.). Mc Graw Hill. Carlos Kubrushy, S. (2007). *Measure Theory*. Springer. Donald Coln, L. (2013). *Measure Theory* (2nd ed.). Birkhauser. Paul Halmos, R. (1914). *Measure Theory*. Springer.		
Outcomes	After the successful completion of this course, the student will be able to: ➢ Unify classical Lebesgue integration and classical summation. ➢ Provide examples for Banach spaces and their duals through Lebesgue spaces. ➢ Applications of continuous functions were elaborately studied using L^p-spaces approximation. ➢ Understand the consequences of Radon-Nikodym theorem and The Riesz representationtheorem. ➢ Get the knowledge of product measures, Convolution and Distribution functions.	

Course Designed byDr. R. Jeyabalan
Assistant professor Department of Mathematics

Semester - I		
Course Code: 571103	**General Skills in Fourier Analysis**	**Credits: 4**

Objectives	➢ To introduce the Concepts of Fourier series, Hilbert spaces and Fourier transforms forclassical functions**.** ➢ To introduce orthonormal bases and completion fourier series ➢ To introduce the Fourier transform for distributions. ➢ To acquire Fourier transforms on abstract dual groups along with general convolutions. ➢ To introduce the Fundamentals in Abstract Fourier Analysis.
Unit - I	Periodic functions-Exponentials - The Bessel Inequality - Convergence in the L^2-Norm – Uniform Convergence of Fourier series - Periodic functions Revisited.
Unit - II	Pre-Hilbert and Hilbert spaces - l^2 spaces - Orthonormal Bases and Completion- Fourier series Revisited**.**
Unit - III	Convergence Theorem- Convolution - The Fourier Transform - The inversion Formula - Plancherel's theorem - The Poisson Summation Formula -Theta series.
Unit - IV	Definition of Distributions – The derivative of a distribution - Tempered Distributions – Fourier Transform for distributions.
Unit - V	Dual groups - The Fourier transform on dual groups - Convolution.

Suggested Readings:-

Anton Deitmar. (2005). *A first course in Harmonic Analysis* (2nd ed.). Springer.

Gerald Folland, B. (2009). *Fourier Analysis and its Application*. American Mathematical Society.

Loukas Grafakos. (2008). *Classical Fourier Analysis* (2nd ed.). Springer.

Yitzhak, Katzelson. (2004). *An introduction harmonic Analysis* (3rd ed.). Cambridge Mathematical library.

Outcomes	After the successful completion of this course, the student will be able to: ➢ Understand periodic functions and Uniform convergence of fourier series. ➢ Get skills in understanding Hilbert spaces and Fundamentals in Fourier analysis. ➢ Get skills in understanding The Poisson summation formula and theta series. ➢ Study the classical functions and for distributions. ➢ Get the skills in Dual groups of the Fourier transform on dual groups of the Convolution.

Course Designed byDr. R. Jeyabalan

Assistant Professor Department of Mathematics

Specialization Course		
Course Code: 571201	**Functional Analysis**	**Credits: 4**
Objectives	➢ Focus on the definition of Topological vector spaces. ➢ Aim to introduce Banach - Steinhaus theorem. ➢ Introducing Milman's theorem and Hahn- Banach theorem. ➢ To investigate the compact operators. ➢ To illustrate how general methods of Haar measure on a compact space can be used.	
Unit - I	**Topological Vector Spaces:** Normed spaces - vector Spaces – topological spaces - topological vector spaces -invariance - types of topological vector spaces - separation properties - Linear mappings - finite dimensional spaces- **Metrization** - boundedness and continuity –Seminorms and Local Converxity- quotient spaces- Examples.	
Unit - II	**Completeness:** Baire category - Baire's theorem-the Banach – Steinhaus Theorem - the open mapping theorem - the closed graph theorem - bilinear mapping.	
Unit - III	**Convexity:** The Hahn – Banach theorems - weak topologies –the weak topology of atopological vector space-the weak* topology of a dual space-compact convex sets- extreme points- the Krein Milman theorem- Milman's theorem.	
Unit - IV	**Duality in Banach Spaces:** the normed dual of a normed space-duality- the second dual of a Banach space-Annihilators-Duals of subspaces and of quotient spaces-adjoints-compact operators.	
Unit - V	**Some Applications-**A Continuity therorem-Closed Subspaces of L^p –Spaces-The range of a vector- valued measure-A generalized Stone-Weierstrass theorem- Two interpolation theorems-Kakutani's fixed point theorem-Haar measure on compact groups-Uncomplemented subspaces.	

Suggested Readings:-

Rudin, W. (2017). *Functional Analysis*. (2nd ed.), Tata McGraw – Hill, 424 pp.

Bachman, G., and L. Narici. (2000). *Functional Analysis*. Dover Publications, 1058pp.

Jean – pierre Aubin .(2000). *Applied Functional Analysis*. (2nd ed.), John Wiley & Sons, 510pp.

Kantororich, L.V., and G.P. Akilov. (2014). *Functional Analysis*. (2nd ed.), Pergemon Press, 604pp.

Outcomes	After the successful completion of this course, the student will be able to: ➢ Understand better the definition of Topological vector spaces ➢ Understand the proof of Hahn- Banach theorem ➢ Know the basic theory of Milman's theorem ➢ Consolidate earlier knowledge of compact operators through applications. ➢ Understand the applications of Haar measure on a compact space

Course Designed byDr. B. Sundaravadivoo

Assistant Professor Department of Mathematics

Specialization Course		
Course Code: 571202	**Commutative Algebra**	**Credit: 4**

Objectives	➢ Introduce the concept of free module, projective modules, tensor products and Flat modulesas the generalization of a vector space. ➢ Study different types of ideals on local rings, localization and its algebraic applications. ➢ Establish Noetherian modules, Primary decomposition and Artinian modules ➢ Discuss about Integral extensions and its closed domains. ➢ Demonstrate the Discrete valuation rings and Dedekind domains.
Unit - I	**Free modules** - Projective modules - Tensor products - Flat modules.
Unit - II	**Ideals** - Local rings - Localization - Applications.
Unit - III	**Noetherian modules** - Primary decomposition - Artinian modules - Length of modules.
Unit – IV	**Integral elements** - Integral extensions - Integral closed domains -Finiteness of integral closure.
Unit - V	**Valuation rings** - Discrete valuation rings - Dedekind domains.

Suggested Readings:-

Gopalakrishnan, N.S. (2015). *Commutative Algebra* (2nd ed.). University press.

Ernst Kunz. (1985). *Introduction to Commutative Algebra and Algebraic Geometry*, Birkhauser.

George Kemper. (2011). *A Course in commutative Algebra*. Springer.

Sharp, R.Y. (2000). *Steps in Commutative Algebra* (2nd ed.). Cambridge Press.

Outcomes	After the successful completion of this course, the student will be able to: ➢ Allocate features to free modules and demonstrate variety of examples. ➢ Access properties implied by different ideals on local rings and localizations. ➢ Analyze the Noetherian modules and Artinian modules by giving some illustration ➢ Determine integral elements, integral extensions and finiteness of integral closure. ➢ Understand the basic concepts of discrete valuation rings.

Course Designed byDr. J. Vimala

Assistant Professor Department of Mathematics

Specialization Course		
Course Code: 571203	**Domination In Graphs**	**Credits: 4**
Objectives	➢ Calculate the bounds on the domination number in terms of order and size. ➢ Discuss the bounds of various domination parameters in terms of degree. ➢ Develop the interesting problem of domination numbers of planar graphs with smalldiameter. ➢ Discuss the concept independent sets and irredundant set of the graph. ➢ Discuss the domination number which does not increase when the graph is modified byremoving a vertex or an edge.	
Unit - I	**Dominating Queens** – Dominating Sets in Graphs – Sets of Representatives – School Bus routing – Bounds In Terms Of Order – Bounds in terms of order, Degree and Packing - Bounds in terms oforder and size.	
Unit - II	**Bounds in terms of Degree**, Diameter and Girth – Bounds in terms of independence and covering –	
Unit - III	**Domination,Independence & Irredundance-**Hereditary and Super hereditary properties –Independent sets – Dominating sets – Irredundant sets.	
Unit - IV	**The domination chain** – Extension using maximality and Minimality. (Non-trivial proofs of resultswithout proofs are excluded from the syllabus)	
Unit - V	**Changing and Unchanging Domination:** Changing:Vertex removal(CVR)-Edge removal(CER)-Edge addition(CEA)-Unchanging: Vertex removal(UVR)-Edge removal(UER)-Edge addition(UEA).	

Suggested Readings:-

Teresa W.Haynes, Stephen T.Hedetniemi,Peter J.Slater. (1998). *Fundamentals of Domination in Graphs*. Marcel Dekker Inc..

Balakrishnan, R., and K. Ranganathan. (2012). *A text Book of Graph Theory*. (2nd ed.), 292pp

Bock Boon Lim. (2000). *On the Dominating Number of a graph*. National University of Singapore, 290pp.

Shaohwiwang. (2016). *On Topological indices and Dominating Numbers of graph*. University of Mississippi, 320pp.

Outcomes	After the successful completion of this course, the student will be able to: ➢ Demonstrate a thorough knowledge of the NP completeness of the Domination problem,Identify the total domination number of graphs. ➢ Solve the irredundant number and matching number, Prove results for hereditary and super hereditary properties. ➢ Find the neighborhood knockout number and replacement. ➢ Understand a thorough knowledge of extension using maximality and minimality. ➢ Examine the effects on domination when the graphs is modified by deleting a vertex ordeleting or adding an edge.

Course Designed by Dr. S. Amutha
Assistant Professor Ramanujan Centre for Higher Mathematics

Specialization Course		
Course Code: 571204	**Fractional Differential Equations**	**Credits: 4**
Objectives	➢ Focus on the definition of Special Functions ➢ Aim to introduce Different types of fractional derivatives and integrals ➢ Introducing Existence and Uniqueness theorem ➢ To investigate the short-memory principle ➢ To illustrate how general methods of fractional controllers can be used	
Unit - I	Special functions of the fractional calculus: Gamma function - Mittag-Leffler function-Generalized-Mittag-Leffler function-Functions of the Mittag-Leffler Type.	
Unit - II	**Fractional derivatives and Integrals:** Grunwald - Letnikov Fractional Derivatives Riemann - Liouville fractional derivatives - Some Other approaches - Sequential fractional derivatives - Left and right fractional derivatives -Properties of fractional derivatives - Laplace Transforms of fractional derivatives.	
Unit - III	**Existence and uniqueness theorems:** Linear fractional differential equations - Fractional differential equation of a general form - Existence and Uniqueness theorem as a method of solution - Dependence of a solution on initial conditions. The Laplace Transform method: Standard fractional differential equations-Ordinary linear fractional differential equations.	
Unit - IV	**Numerical solution of fractional differential equations:** Initial Conditions- Numerical solution - Examples of numerical solutions - The "Short -Memory" Principle in Initial Value Problems for fractional differential equations.	
Unit - V	**Fractional – order systems and controllers:** Fractional – order systems and fractional - OrderControllers-Example - On Fractional- order system Identification.	

Suggested Readings:-

Podulbny, I. (1999). *Fractional Differential Equations*. Academic Press.

Constantin, M., Gheorghe, D., Jose Antonio, T.M. (2019). *Introduction to Fractional Differential Equations* (1st ed.).Springer International Publishing.

Kilbas, A.A., Srivastava, H.M., Trujillo, J.J. (2006). *Theory and Applications of Fractional Differential Equations* (1st ed.). Elsevier Publication.

Zhou, Y. (2016). *Basic Theory of Fractional Differential Equation* (2nd ed.). World Scientific.

Outcomes	After the successful completion of this course, the student will be able to: ➢ Understand better the definition of Special Functions. ➢ Understand the proof of Different types of fractional derivatives and integrals. ➢ Know the basic theory of Existence and Uniqueness theorem. ➢ Consolidate earlier knowledge of short-memory principle through applications. ➢ Understand the applications of fractional controllers.

Course Designed byDr. B. Sundaravadivoo

Assistant Professor Department of Mathematics

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