DEPARTMENT OF MATHEMATICS

POSTGRADUATE PROGRAMMES IN PURE AND APPLIED MATHEMATICS

FACULTY OF PHYSICAL SCIENCES
UNIVERSITY OF NIGERIA,
NSUKKA

DEPARTMENT OF MATHEMATICS

POSTGRADUATE PROGRAMMES IN PURE AND APPLIED MATHMATICS

LISTS OF APPROVED SUPERVISORS

PROFESSORS

Osilike, M.O.	B.Sc., M.Sc., Ph. D (Nigeria), DICTP (Trieste)	Nonlinear Operator Theory
Oyesanya, M.O.	B.Sc., M.Sc., Ph. D (Nigeria)	Applied Mathematics
Ochor, F.I.	B.Sc., M.Sc. (Nigeria), M.Phil, Ph. D (SISSA)	Differential Equations
Mbah, G.C.E	B.Sc., M.Sc. (BENIN), Ph. D (Nigeria)	Biomathematics and Mathematical Modelling

SENIOR LECTURERS

Isiogugu, F. O	B.Sc., M.Sc., Ph. D (Nigeria),	Nonlinear Operator Theory
Akuchu, B. G.	B.Sc.(NAU), M.Sc., Ph. D (Nigeria),	Nonlinear Operator Theory
Shehu, Y.	B.Sc. (Ladoke Akintola), M.Sc. (Nigeria), Ph. D (AUST)	Functional Analysis

PHILOSOPHY

It is becoming very obvious that Mathematics is the arrowhead of development not only in the Science- engineering sciences, physical sciences, social sciences, medical sciences- but indeed in all facets of the economy of any nation. Thus the postgraduate programme in mathematics is designed to provide training in the theory and application of mathematics in every area of human endeavour and stimulate creative thinking and research in every methods and solution of real life problems.

OBJECTIVES:
Our postgraduate programmes have the following objectives:

Production of high calibre mathematicians equipped to man leadership positions in academia, industries, research centres where a sound knowledge of mathematics and mathematical thinking and skills are required particularly in a burgeoning economy like ours.
Training a crop of mathematicians that can give incisive breakthroughs in understanding, and modelling of epidemiological diseases, engineering structures, and concise development and progression in modern day diseases like cancer, diabetes, high blood pressure etc.
Training people that can stand with their heads high up engaging in cutting edge research in mathematics.

The main objectives of the PGD programme is to open the door of the universal language of mathematics to non- mathematics graduates to enter into productive field of science and

technology, communication and information technology, financial mathematics, and give to those interested and qualified a solid background in mathematics for higher degrees and scientific breakthroughs.

ADMISSION REQUIREMENTS

PGD: Candidates for the PGD must possess a first degree in related disciplines as noted above with a CGPA of not less than 2.5/5.0 in addition to General Certificate of Education (GCE) O/L with five credits including English Language, Mathematics, Physics and any other two physical science subjects. The Programme is to last for two Semesters.

MSC: Candidates with Bachelor's degree from approved university must obtain a minimum of second class lower division with at least a CGPA of 2.5/5.0
All candidates must have five credit passes including English Language, Mathematics and two relevant science subjects at O'Level preferably Physics and Chemistry or Biology or Geography.

PHD: Candidates with Bachelor's degrees from approved university must obtain a minimum of second class lower division with at least a CGPA OF 2.5/5.0
All candidates must have five credit passes including English, Mathematics and two relevant science subjects at O'Level preferably Physics and Chemistry or Biology or Geopraphy.
Candidates must have Academic Master's degree in Mathematics in relevant areas with CGPA of 3.5/5.0 and thesis score not lower than 60%.
Candidates must demonstrate adequate intellectual capacity, maturity and effective decision making and problem solving potentials.

MODE OF STUDY:

MSC: The Academic Master's degree shall be for a minimum of **three** and maximum of **Five** semesters by coursework and project report or by coursework and research dissertation for full time students and **minimum** of Five and **maximum** of Eight semesters for part-time students. Every Master's degree student shall take 24 credit units from the core courses **INCLUDING** general courses, project/dissertation and seminar AND 6 credit units from the elective courses relevant to area of specialization and 3 credit units from PG School organized courses namely:
PGC 602 ICT and Research Methodology 3 Credit Units

PHD: The doctoral Ph.D shall be for six semesters (minimum) and ten semesters (maximum) by coursework and research thesis. For Part-time students, it is for a minimum of eight Semesters and maximum of twelve semesters. Every doctoral student shall take 30 credit units INCLUDING thesis of 12 Credit Units, seminar 6 units and 12 credit units of taught courses consisting of 6 credit units from departmental courses and 3 credit units from PG School organized courses namely: PGC 701 Synopsis and Grant writing 3 Credit Unit

POST GRADUATE DIPLOMA (PGD) SEMESTER COURSES

The PGD program in mathematics is designed to cater for graduates of other Departments in Physical Sciences, Engineering, Mathematics Education and mathematically related disciplines who may want to pursue higher degrees in Mathematics. The PGD program is NOT meant for graduates of Mathematics with Third Class.

FIRST SEMESTER.

MTH 511	ANALYTICAL DYNAMICS	3
MTH 521	NUMERICAL ANALYSIS	3
MTH 531	FINANCIAL MATHEMATICS	3
MTH 541	REAL ANALYSIS	3
MTH 551	ABSTRACT ALGEBRA	3
MTH 561	PARTIAL DIFFERENTIAL EQUATION	3
MTH 571	MATHEMATICAL METHODS	3
MTH 581	MEASURE AND INTEGRATION	3

SECOND SEMESTER

MTH 512	COMPLEX ANALYSIS	3
MTH 522	ORDINARY DIFFERENTIAL EUATIONS	3
MTH 532	TOPOLOGY	3
MTH 542	FUNCTIONAL ANALYSIS	3
MTH 552	ADVANCED CALCULUS	3
MTH 562	MATHEMATICAL MODELING	3
MTH 567	OPERATION RESEARCH	3
MTH 582	CONTROL THEORY	3
MTH 592	**BANACH ALGEBRA AND SPECTRAL Theory**	**3**

Minimum of 15 units to be taken every semester.

Total = 30 units

Project = 4 units to be taken DURING first semester to the students and examined at the end of the second semester. The Cumulative credit that must be earned to continue the M.Sc programme is minimum of 30 Units with a CGPA of not less than 3.50/5.0.

COURSE CONTENTS

MTH 592 BANCH ALGEBRAS AND SPECTRAL THEORY

A brief review of Banach Space Theory .Basic of Banach Algebras. The functional Calculus. The spectrum. Commutative Banach Algebra. Bounded Operators on Hilbert Space, Unbounded Operators. The Spectral Theory of Operators C^A-Algebras and Von Neumann Algebras.

MTH 542 FUNCTIONAL ANALYSIS

Normed Linear Spaces. An introduction to Operators Hilbert Space. Topological Vector Spaces. The Hahn-Banach Theorem. Weak Topologies and Dual Spaces. Local Compactness and External Points. Operator Theory.

MTH 551 ABSTRACT ALGEBRA

Basic Axioms and Examples of Groups Subgroups and Lattice of Subgroups. Quotient Groups and Homomorphisms.P-group Nilpotent Groups and Solvable Groups. Definition of Ring. Ring Homomorphism and Quotient Rings. Euclidean Domains, Principal Ideal Domains and Unique Factorization Domains. Polynomial Rings .Review of Field Theory and Galois Theory.

MTH 532 GENERAL TOPOLOGY

Brief Review of Set Theory and Logic. Topological Spaces and Continuous Functions. Connectedness and Compactness. Countability and Separation Axioms. The Tychonoff Theorem.Metrization Theorem and Paracompactness. Complete Metric Spaces and Function Spaces.Baire Space and Dimension Theory.

MTH 552 ADVANCE CALCULUS

Function of Several Variables. Functions from R^n to R^n. Partial Derivatives. Jacobian.Inverse Function Theorem. Implicit Function Theorem.

MTH 561 PARTIAL DIFFERENTIAL EQUATIONS

Basic examples of linear partial differential equations, their fundamental equations and solutions. The Cauchy problem for the linear second order partial differential equations in two independent variables: existence and uniqueness of solutions; normal forms. Riemann method. Hyperbolic, elliptic and parabolic partial differential equations. Boundary value and mixed boundary value problems.

MTH 541 REAL ANALYSIS

Review of: The Concept of upper and lower limits of bounded sequences. Category Spaces, the Bairew Category Lemma, the Unit Open Ball Lemma, Zorn's Lemma, Basic Properties of Hilbert Space and Banach Spaces. Theory of Functions of a Real Variable. Lebesgue Measure and Integral. Differentiation and Integration.

MTH 581 MEASURE AND INTEGRATION

Basic Definitions and Examples. Measures and Outer Measures. Extensions of Measures. Measurable Functions. Integration. General Set Functions.

MTH 511 ANALYTICAL DYNAMICS (3)

Motion of rigid bodies. Generalized coordinates conservative fields. Degrees of freedom. Holonomic and non-holonomic systems. Languages equation for holonomics systems, force dependent coordinates only, force obtainable from a potential. Hamilton's equation, Impulsive motion, Small oscillative. Normal modes, Three-dimensional motion. Eulerian angles, spinning tops, gyrostats, rolling bodies and frames of reference. Calculus of variation.

MTH 521 NUMERICAL ANALYSIS

Numerical differentiation and integration by various methods. Guassian quadrature. Numerical method for ordinary and partial differential equations. Boundary value problems. Computation of eigenvalues of symmetric matrices. Finite, Difference methods, equations and operatives. Discrete variable methods for solutions of IVPS ordinary differential equations. Discrete and continuous Tan methods for solving IVP-ODES, error analysis.

MTH 531- FINANCIAL MATHEMATICS (3)

Measures of central tendency, relations and correlations. Distribution theories and types of distributives. Stocks and shares. Risks analysis of stock and shares. Investments and returns on investments. Portfolio selection. Optimizing returns on portfolios selection.

MTH 571- MATHEMATICAL METHODS

Gradient, divergence and curl of vectors. The integral definition of gradient, divergence and curl of vectors curvilinear coordinates. Simple notion of tensors. Calculus of variation; Lagrange's functional and associated density. Conditions for strong and relative extremum. Geodesic problems. Variable end point theorems and related theorems. Isoperimetric problems. Variational integral transforms: Laplace, Fourier, Hankel and Mellen transforms. Complex variable methods, convolution theorem and applications to solutions of IVP/BVP ODES. Series solutions of second order equation about ordinary and regular singular points: application.

MTH 562 MATHEMATICAL MODELLING

Methodology of model building. System study and abstractions of relevant information for mathematical formulations of the required equations. Various types of mathematical model formulation: Descrete, Stochastic, Differential, Integra-differential, algebraic difference etc. application of the art of mathematical modelling to; environmental studies, economy, physical, biological, drug Kinetics, Chemical reactions. Simulations and interpretation of model results.

MTH 572: OPERATION RESEARCH (3)

Inventory problem; graph and networks; stock control; quelling problems. Decision theory. Non-linear programming algorithms and their reliability. Scheduling. Special types of linear programming problems. The dual simplex method. Advanced topics in Mathematical programming. Dynamics programming. Game theory. Integer and mixed programming.

MTH 582 CONTROL THEORY

Existence, boundedness and periodicity for solutions of linear systems of differential equations with content coefficients. Stability theorems and analysis for differential equations: Lyapuno and other methods. Sets: reachable sets, attainable sets. Dynamical systems in the space. Reachability, stabilizability and detectability. Equivalence of controllability and pole assignability.

MTH 512 COMPLEX ANALYSIS

Analytic functions and conformal mappings. Analytic continuitiess and elementary Riemann surfaces. Transformations, infinite products; entire functions: include order and types. The product theorems of Weierstrass and others; the Riemann mapping theorems.

MAT 506 Group Representation Theory 3 Credit Units

Representation of groups by linear transformations; group algebras, character theory and modular representations. Representation theory of algebraic groups, representation of finite groups; representation of compact and locally compact groups; representation of Lie groups. Unitary representation theory.

MASTER'S (M.Sc) SEMESTER COURSES

The department offers Academic Master's Degree and Doctor of Philosophy (Ph.D) Programmes in Pure and Applied Mathematics with specialization in the following areas: Topology, Real Analysis, Functional Analysis, Differential Equations, Continuum Mechanics, Solid Mechanics, Fluid Dynamics, Mathematical Modelling, Optimization, Control Theory, Operator Theory , Summability Theory, Financial Mathematics and Biomathematics

CORE COURSES

MTH 800/MTH 561 Research Project/Dissertation 6 Credit Units
MAT 801 Algebra 3 Credit Units

MTH 802 Topology	3 Credit Units
MTH 803 Real Analysis	3 Credit Units
MTH 804 Complex Analysis	3 Credit Units
MTH 805 Partial Differential Equations	3 Credit Units
MTH 807 Advanced Methods of Applied Maths.	3 Credit Units
MTH 806 Asymptotic Method	3 Credit Units
MTH 808 Geometry of Branch Space	3 Credit Units
MTH 824 Seminar	3 Credit Units
MAT 817 Introduction to Mathematical Modelling	3 Credit Units

REQUIRED GENERAL CORE COURSES

PGC 601 ICT and Research Methodology	3 Credit Units

ELECTIVE COURSE

The M .Sc. Student in addition to the above specified core course must take 6 Credit Units from the Following elective courses:

(A) PURE MATHEMATICS OPTION

MAT	809	Group Representation theory	3 Credit Units
MAT	810	Number Theory	3 Credit Units
MAT	811	Category Theory	3 Credit Units
MAT	812	Lie Groups	3 Credit Units
MAT	813	Differential Manifold	3 Credit Units
MAT	815	Integral Equations	3 Credit Units
MAT	816	Theory of Distributions	3 Credit Units

(B) APPLIE MATHEMATCS OPTION

MAT	818	Quantum Mechanics	3 Credit Units
MAT	819	Fluid Mechanics	3 Credit Units
MAT	820	Elasticity	3 Credit Units
MAT	821	Electromagnetic Theory	3 Credit Units
MAT	822	Visco- Elasticity and Plasticity	3 Credit Units
MAT	823	Control Theory	3 Credit Units
MAT	824	Finite Element Methods	3 Credit Units
MAT	825	Biomathematics	3 Credit Units
MAT	827	Fractional Calculus and Applications	3 Credit Units

DOCTORAL (Ph.D) SEMESTER COURSES

CORE COURSES

REQUIRED GENERAL CORE COURSES

PGC 701	Synopsis and Grant writing	3 Credit Unit

ELECTIVE COURSES

The Ph. D Students in addition to the above specified core course must take 6 Credit Units from the following elective courses:

(C) PURE MATHEMATICS OPTION

MAT 801	Algebra	3 Credit Units
MAT 809	Group Representation theory	3 Credit Units
MAT 810	Number Theory	3 Credit Units
MAT 811	Category Theory	3 Credit Units
MAT 812	Lie Groups	3 Credit Units
MAT 813	Differential Manifold	3 Credit Units
MAT 814	Theory of Integration	3 Credit Units
MAT 815	Integral Equations	3 Credit Units
MAT 816	Theory of Distributions	3 Credit Units
MAT 817	Introduction to Mathematical Modelling	3 Credit Units

(D) APPLIED MATHEMATIC OPTION

MAT 818	Quantum Mechanics	3 Credit Units
MAT 819	Fluid Mechanics	3 Credit Units
MAT 820	Elasticity	3 Credit Units
MAT 821	Electromagnetic Theory	3 Credit Units
MAT 822	Visco-Elasticity and Plasticity	3 Credit Units
MAT 823	Control Theory	3 Credit Units
MAT 824	Finite Element Methods	3 Credit Units
MAT 825	Biomathematics	3 Credit Units
MAT 827	Fractional Calculus and Applications	3 Credit Units

DISCRIPTION OF COURSES

PGC 701	Synopses and Grant Writing	3 Credit Units

Identification of types and nature of grants and grant writing: mining of grants application calls on the internet. Determining appropriate strategy for each grant application. Study of various grant application structures and contents and writing of concept notes, detailed project description, budgeting and budget defense. Study of simple grant writings in various forms and

writing of mock research and other grants. Identification of University of Nigeria synopsis structure and requirements (Introduction, Methodology and Results).Determining the content of each sub-unit of the synopsis. Steps in writing the synopsis from the Dissertation/Thesis document. Structural and language issues. Common errors in synopsis writing and strategies for avoiding them. The roles of the students and supervisors in the production of a synopsis. Writing of mock synopsis. All registered Ph. D students must attend a solution-based interactive Workshop to be organized by the school of postgraduate studies for a practical demonstration and application of the knowledge acquired from the course conducted by selected experts.

MTH 801 Algebra 3 Credit Units

Sylow theorems, direct products, fundamental theorem of finite Abelian groups, fields of quotient, Euclidean rings, polynomial rings over commutative rings, inner product spaces, theory modules, sub-modules, quotient modules, module over principal ideal domains. Application of finitely generated Abelian group field extension fields elements of Galois Theory, solvability radicals.

MTH 802 Topology 3 Credit Units

Review of categories and functions. Homology, fundamental group, covering transformation, simplicial complexes. Singular homology. Universal co-efficient theorem for homology and cohomology. Spectral sequence.

MTH 803 Real Analysis 3 Credit Units

Measures and integration. Outer measure, Lebesgue Measure. Basic properties of Banach and Hilbert Spaces. Operators, Duality. Basic theorems in functional analysis. Classical Banach Spaces. Spectral theory of operators in Hilbert spaces. L2 space as a Hilbert space. Banach Algebras. Gelfand theory, compact operators. Examples and applications to classical analysis.

MTH 804 Complex Analysis 3 Credit Units

Periodic functions, Weierstrass functions, elliptic curves. Modular forms. Algebraic functions, Riemann surfaces. Covering surfaces, covering transformations. Discontinuous groups of linear transforms, automorphic forms.

MTH 805 Partial Differential Equations 1 3 Credit Units

Basic examples of linear partial differential equations, their fundamental equations, and their fundamental solutions. Existence and regularity of solutions (Local or Global) of the Cauchy problems; boundary value problems and mixed boundary value problems. The fundamental solutions of their partial difference equations.

MTH 806 Asymptotic Method 3 Credit Units

Asymptotic sequences and series, operations on asymptotic series, asymptotic evaluation of functions defined by contour integral including methods of stationary phase and steepest descant,

uniform asymptotic expansion, asymptotic solutions of ordinary and partial differential equations, WKB approximations, singular perturbation.

MTH 807 Advanced Methods of Applied Maths 3 Credit Units

The emphasis will be on advanced methods of solution rather tan theory of ordinary and partial Differential equations. Power and product series and special functions, contour integral representation, integral transforms, conformal mapping. Wiener-Hopf techniques.

MTH 808 Geometry of Banach Space 3 Credit Units

Uniform convex spaces and their characteristics inequalities. Strictly convex spaces, The Modulus of Convexity. Uniformly Smooth Banach Spaces and their Characteristics inequalities, the Modulus of Smoothness, Fretchet and Gateaux Differentiability. Duality Maps. Some Applications.

MTH 809 Group Representation Theory 3 Credit Units

Representations of groups by linear transformations; group algebras, character theory and modular representations. Representation theory of algebraic groups; representation of finite groups; representation of compact and locally compact groups; representation of Lie groups. Unitary representation theory.

MTH 810 Number Theory 3 Credit Units

Algebraic integers. Completions, the different and discriminant. Cyclotomic fields. Parallelotopes. Class- Number. Ideles and Adeles. Elementary properties of Zeta-functions. L-functions.

MTH 811 Category Theory 3 Credit Units

Categories, functions natural-transformation. Functor categories, limits. Products and coproducts. Pushbacks and Pushouts, adjoining functors. Normal and exact categories: Abelian categories, quotient categories.

MTH 812 Lie Groups 3 Credit Units

Lie groups and their Lie algebras, subgroups. Matrix groups: One-parameter groups, exponential map, Campbell-Hausdorff formula, Lie algebra of a matrix group, integration on matrix groups. Abstract Lie group.

MTH 813 Differentiable Manifolds 3 Credit Units

General manifolds. Topics such as smooth mappings, Immersions, submersions, transversality, intersection theory, vector fields of manifold; orientation of manifolds: Gaussian curvature, Riemannian manifolds, differential forms, integration on manifolds tensors and connections are included.

MTH 814 Theory of Integration 3 Credit Units

The theory on closed and bounded intervals: Gauges and integrals. Basic properties of the integral. The fundamental theorems of calculus. The Saks-Henstock Lemma. Measurable functions. Absolute integrability. Convergence theorems. Integrability and mean convergence. Measure, measurability and multipliers. Mode of convergences, substitution theorems. Applications. The theory of infinite intervals: General insight into intergration on infinite interval.

MTH 815 Integral Equations 3 Credit Units

Basic existence theorems: Equations with L2 kernels: Fredholm Theory; Nonlinear equations, Schauder Fixed-point theorem. Dual integral and series equations. Wiener_Hope equations and Technique. Singular integral equations. Applications.

MTH 816 Theory of Distributions 3 Credit Units

Topological vectors spaces and generalized functions; Distribution calculus and topology; convolution; Tempered distributions and their Fourtier transforms. Integral transforms of Mathematical Physics. Application.

MTH 817 Introduction to Mathematical Modelling 3 Credit Units

Mathematical modelling. The Art of transforming Real Life Situation into Mathematical statements. Examples will be drawn from Areas such as Biology, Business, Deformable Media, Industry and other dynamical system. Case studies.

MTH 818 Quantum Mechanics 1 3 Credit Units

Background of the axiomatic approach to Nul et al. axioms of continuum and Basic Concepts. Constitutive relations. Equations of Motions and other Equations of Motions and other Equations of Balance. The place of the Classical Theories.

MTH 819 Fluid Mechanics 3 Credit Units

Thermodynamics Compressive flow; waves; shocks; supersonic flow; Boundary Layer Theory; stability Turbulence.

MTH 820 Elasticity 3 Credit Units

Formulation of the Linear Theory; General Theorems; Plane Strain and generalized plane stress; Airy's solution: Papkovich- Neuber representation; Basic singular solutions; Boundary- Value and Boundary initial value problem.

MTH 821 Electromagnetic Theory 3 Credit Units

Maxwell's Equations; Electromagnetic Potentials: Tensor Calculus; Stress and Energy; Electro-Static and Magnetostatics, plane waves, cylindrical and spherical waves; Boundary Value Problems; Relativistic Kinematics and Lorentz Transformation: Electrodynamics.

MTH 822 Quantum Mechanics 11 3 Credit Units

Schrodinger equations; Stone's Theeorem and its applications. Unitary transformations: Heisenberg representation : Measurement: Quantum Theory of Scattering ;Angular Momentum. Motion in external field; Base and Fermi Statistics: Perturbation Theory.

MAT 823 Visco-Elasticit And plasticity 3 Credit Units

Characteristics of various visco-elastic and Plastic material Basic equations .Boundary Value problems. Elastic-plastic problem.

MTH 824 Control Theory 3 Credit Units

Dynamical System in the State Space. Reachability. Stabilizability and Detectability. Equivalence of Controllability and Pole Assignability. The Calculus of Variations. Generalized Huygen's principle. The Algebraic Riccati Equation. Lyapunov Stability. Applications to Economic Stabilization. Planning. Manpower Development. Resource Allocation under Constraints, etc Case Studies.

MTH 825 Finite Element Methods 3 Credit Units

Introduction to the Finite Element Method: Formulation of Finite Element Method using the principle and Virtual Displacement. General Iso-parametric Formulation, and Variational Techniques. Generalization of the theory. Application of the Finite Element Method to the solution of Engineering problems e.g. In Solid Mechanics. Heat Transfer. Fluid Dynamics and Mass Transfer. Development of Appropriate Computer programme. Case Studies.

MTH 826 Biomathematics 3 Credit Units

Mathematical Methods of Deterministic or Stochastic aspects of Biological Systems e.g., Population dynamics, species interaction malaria epidemic, etc.

MTH 827 Fractional Calculus and Applications 3 Credit Units

Preliminaries –function spaces, continuity ,special functions of the fractional calculus –gamma functions, Mittag-Leffler functions; fractional integrals and fractional derivatives ;fractional differential equations ;methods of solving FDEs-Laplace transforms methods, fractional Green's function ; Applications of models in engineering,-Physics, Fluid flows, Cancer and epidemiology.