COURSES FOR 2020/2021 ACADEMIC YEAR
MSc PROGRAMME IN MATHEMATICAL SCIENCES FOR TEACHERS

Course	Credits	Course Description
YEAR 1		
Skills Courses (Core)		
Block 1 (23 November to 18 December 2020)		
MMST 801s	3	Mathematical Problem Solving
MMST 805s	3	Technology for Teachers in Mathematics
Block 2 (4 January - 29 January 2021)		
MMST 807s	3	Introduction to Probability Theory
Block 3 (1 February to 26 February 2021)		
MMST 813s	3	Algebra and Geometry for Teachers
Block 4 (1 March - 26 March 2021)		
MMST 809s	3	Statistics for Teachers
Block 5 (29 March to 23 April 2021)		
MMST 821s	3	Mathematics Curriculum and Classroom Practices
Block 6 (26 April to 21 May 2021)		
MMST 811s	2	Calculus
Block 7 (24 May to 18 June 2021)		
MMST 823s	3	Assessment in Mathematics Education
Block 8 (21 June to 9 July 2021)		

MMST 825s	3	Academic Writing and Research Methods
Block 9 (12 July to 6 August 2021)		
MMST 819s	3	Psychological Applications in Mathematics Education
Block 10 (9 August to 3 September 2021)		
MMST 815s	3	Introduction to Python
MMST 803s	3	Physical Problem Solving
Block 11 (6 September to 1 October 2021)		
MMST 817s	3	Introduction to Vectors and Mechanics
YEAR 2		
Review Courses (Electives)		
Block 12 (4 October to 29 October 2021)		
MMST 802s	3	Introduction to Statistical Programming Languages
MMST 804s	3	Analysis
MMST 806s	3	Discrete Mathematics
Block 13 (1 November to 26 November 2021)		
MMST 808s	3	Introduction to Data Science
MMST 810s	3	Introduction to Quantum Mechanics
MMST 818s	3	Introduction to Financial Mathematics
Block 14 (29 November to 24 December)		
MMST 816s	3	Complex Analysis
MMST 820s	3	Computational Finance

MMST 822s	3	Introduction to Number Theory
Block 15 (3 Janurary to 28 January 2022)		
MMST 814s	3	Advanced Numerical Methods and Scientific Computing with Python
MMST 812s	3	Dynamical Systems
Block 10 (22 January to 30 June 2022)		
MMST 800s	6	Project Work/Essay

COURSE DESCRIPTIONS

MMST 801s: Mathematical Problem Solving
Bernard Oduoku Bainson, Kwame Nkrumah University of Science and Technology, Ghana.

This course considers a variety of elementary, but challenging problems in different branches of pure mathematics. Investigations, comparisons of different methods of approach, literature searches, solutions and generalizations of the problems will arise in discussions in class. The objective is to illustrate, and gain practical experience of, different approaches to problem solving and research.

MMST 805s: Technology for Teachers in Mathematics
Eyram Schwinger & Douglas D. Agyei, University of Ghana & University of Cape Coast

This course is a shift of ICT teacher professional development towards content-centric approaches which advocates teaching teachers how to teach with ICT tools to meet content learning goals rather than teaching teachers how to use the tools. The course will introduce students to subject-specific applications such as LaTeX, Geogebra, Derive and Spreadsheet in the design designing and implementing lessons with selected effective strategies for teaching and learning mathematics. The course will adopt a systematic but flexible methodology aimed to improve trainees? knowledge and skill in teaching with ICT through iterative analysis, design, development, implementation and evaluation based on collaborations among learners.

MMST 807s: Introduction to Probability Theory
Kwabena Doku-Amponsah, University of Ghana

This will be an introduction to the mathematical treatment of the theory of probabilities on the bases of discrete models and on probabilities with Riemann-densities. We start with elementary probability spaces, the concept of conditional probability, statistical independence, random variables, expectations and variances. Furthermore, we will consider the frequently appearing distributions (Poisson, Binomial, exponential, normal) and their properties. We will treat some limit theorems. In particular, the Poisson limit theorem, generating functions and the central limit theorem.

MMST 821s: Mathematics Curriculum and Classroom Practices
Damian Kofi Mereku, University of Education, Winneba, Ghana

The course will expose students (prospective teachers) to the High School and College of Education mathematics curriculum and classroom practices in Ghana. The course covers the overview (major parts) of the Core Mathematics, Elective Mathematics and College of Education Mathematics curricular. Reflections upon the role of the teacher in operationalizing these curricular must be emphasized, in order to enhance the teacher?s effectiveness in the classroom. These will include analysis of the elements, sequence of mathematics topics,

concept mapping, learning experiences and evaluation of the Ghanaian mathematics curricular at the High School and the College of Education levels. The course will also explore classroom practices that will enhance learning and teaching of mathematics. The course will in particular look at how teachers will impact knowledge on some selected (difficult) topics in mathematics to students. These topics include vectors, mechanics (dynamics and statics), geometry, calculus (kinematics, differential and integral calculus) and other problematic topics to students indicated by the Chief Examiners reports on mathematics (WASSCE and College of Education Examinations). The teacher must emphasize the applications of these topics in the curricular to real life situations.

MMST 809s: Statistics for Teachers

The objective of the course is to introduce students to statistics with emphasis on statistical inference and estimation and the corresponding error analysis associated with estimations. In particular, it will treat topics such as a general introduction to statistics, including the uses and applications of statistics, data and methods of collection, stages of statistical investigation, descriptive analysis of data. Furthermore, we will consider basic concepts of statistical inference, sampling techniques and sampling distributions of sample means, proportions and variances. Estimation: point and interval estimation of parameters (mean, proportion and variance), hypothesis testing: significance tests for parameters including analysis of variance.

MMST 813s: Algebra and Geometry for Teachers
Angela Tabiri, AIMS-Ghana

We give an accessible introduction to algebraic geometry. Algebraic geometry is the study of the solution sets of polynomial equations (algebraic varieties) and has a long, rich history. We will review the concept of Euclidean geometry from an algebraic point of view. In particular, we will treat lines and conic sections (parabola, ellipse, hyperbola) from algebraic perspective. We will investigate these sections as zeros of polynomials and deduce interesting facts. We will use the freely available software Macaulay2 to see more involved examples than would be by hand. Then we will discuss applications and connections to other fields such as mathematical physics and discrete geometry.

MMST 811s: Calculus
Emmanuel K. Essel, University of Cape Coast, Ghana

Calculus is the foundations most students need to apply in fields such as engineering and economics. This course will introduce students to practical ways of teaching calculus to motivate students to study it in practical ways. Topics to be covered include Differential Calculus and Basic Theory on Ordinary Differential Equations. A strong background in Linear Algebra is a prerequisite for this course.

MMST 823s: Assessment in Mathematics Education
Foster Ntow, University of Cape Coast, Ghana

The course is intended to deal with the assessment of cognitive, psychomotor and affective development of students and perspectives of assessment of mathematics teaching and learning. Theories such as cognitivists and socio-constructivists notions of situated learning and their implications for the teaching and assessment of mathematics will be discussed. In addition, both traditional and alternative forms of assessment, such as, portfolio assessment will be discussed and how assessment can influence teaching and vice versa. Students, in this course, will be required to demonstrate the implications of the critical theories and issues discussed in this course for the teaching of mathematics at senior high schools.

MMST 825s: Academic Writing and Research Methods
Kweku Adu-Gyamfi, East Carolina University

The course will introduce the essential features of mathematical writing and publication. In particular the following topics will be treated: Research techniques and Ethics. Referencing and citation style formats (e.g. APA and MLA etc.). Reference management software (e.g. Mendeley), bibliography, table of content, diagram packages etc. Online storage options, data basses, mathematical websites to access research articles from journals such as MathSciNet, etc, and e-books. Aspects of writing mathematics research paper, structure of a thesis.

MMST 819s: Psychological Applications in Mathematics Education
Michael Nabie, University of Education, Winneba, Ghana

This course will examine various psychological theories which underpin effective teaching and learning of mathematics. Learning theories including those of Thorndike, Bruner, Gagné, Skemp, Vygotsky, the Human Information Processing psychologists, as well as the Gestalt psychological school of thought will be covered in detail. The focus on these theories will also include a range of studies that support the theories. The course will also explore various learning styles and their relationships with learning theories in mathematics education. Misconceptions and mathematical concepts development will also be discussed. Students on this course will be encouraged to come out with their own perspectives of teaching and learning based on the theories encountered on the course.

MMST 815s: Introduction to Python

The course covers software development for scientific applications in Python. It assumes limited programming background, but familiarity with general concepts in mathematics (e.g., calculus, probability, and geometry) and basic numerical mathematics (e.g., finite difference methods). The course will focus on the main tasks in scientific computation. To support accomplishing these feats, the course will introduce students to a variety of programming constructs.

MMST 803s: Physical Problem Solving

This course is designed to present physics as a subject used to describe physical phenomena using mathematics. It will involve introducing problems and problem-solving techniques such as conceptualizing and assessing both formulated and proposed conjectures. We will use dynamically changing of point of view, using different reference frames, estimations orders of magnitudes, and dimensional analysis. The problems to be discussed will span topics such as vectors, classical mechanics and electromagnetism. The course is interactive and will require students to critically analyse and communicate findings both orally and written in small groups as well as the entire class.

MMST 817s: Introduction to Vectors and Mechanics, Christopher Okpoti, University of Education, Winneba, Ghana

This course introduces fundamental concepts of mechanics. We will consider rectilinear and planar particle motions. In particular, we will treat the notion of vector functions of a single real variable, kinematics of a particle, relative motion, rectilinear and planar motions of a particle, work, energy and power.

MMST 802s: Introduction to Statistical Programming Languages

The course will use simulation and the bootstrap as tools for understanding statistical inference and probability. As well as making abstract concepts like p-values and confidence intervals, which students often struggle with, concrete, this perspective will probably be unfamiliar to all students (even those who have taken a more traditional statistics course before). Throughout, real data applications will be used to motivate mathematical work, with an emphasis on statistical understanding rather than theorem-proving. In the final week we address statistical modeling, regression, visualization, using R and we examine a case study.

MMST 804s: Analysis

Topics in the course will include: Set, Measures, Constructions of Measures, Lebesgue Integrals, Riemann Integrals, Limit Theorems, Convergence.

MMST 806s: Discrete Mathematics

This course involves Combinatorics, Logic, Introduction to reading and writing mathematical proofs. The objective of the course is to train students to think and write mathematically.

MMST 808s: Introduction to Data Science

Skills in how to manipulate big data are critical is making decisions in the educational, agricultural and health sectors to mention a few. This course will introduce students to the foundations of Data Science and tools needed to collect, store analyse big data. Foundations include Linear algebra and probability, and tools include R programming language.

MMST 810s: Introduction to Quantum Mechanics

This course is aimed at equipping participants with adequate skills to use modern mathematics to address real physical problems. In particular, we will consider algebraic structures such as vector spaces and operators. We will give concise introduction to quantum mechanics considering concepts such as the postulates of quantum mechanics, Heisenberg uncertainty relation, and the Spectral Theorem, and quantum dynamics. The course will discuss the Schrodinger and Heisenberg equations.

MMST 818s: Introduction to Financial Mathematics

This course will equip students with skills needed in investment banking and finance institutions. Markov process, stochastic processes, optimal portfolio choice, forecasting of financial series will be the tools used in the course.

MMST 816s: Complex Analysis

Complex Numbers, Functions of a complex Variable; analytic and holomorphic functions, Complex Integration, Cauchy's integral theorem and Cauchy?s integral formulae Residue Theory and applications.

MMST 820s: Computational Finance

This course is built on the theories of constructions of algorithms, programming and probability and stochastics. Topics the course will cover include Stochastic Calculus, Derivative Pricing, Financial risk management, Numerical Analysis of Data and Advanced Monte Carlo Methods.

MMST 822s: Introduction to Number Theory

This course covers standard topics in analytic and algebraic number theory and their relationship with other fields of mathematics such as topology, complex analysis and representation theory.

MMST 814s: Advanced Numerical Methods and Scientific Computing with Python

Methods for the numerical simulation of mathematical models have been the focus of intensive research for well over 50 years, and the demand for better and more efficient methods has grown as the range of applications has increased. Mathematical models involving partial differential equations (PDEs) as well as ordinary differential equations (ODEs) arise in diverse applications such as fluid flow, physics-based simulation, mechanical systems, earth sciences, and mathematical finance. The course gives a general introduction to differential equations with the main focus on partial differential equations. Additionally, it is shown how to solve those numerically with the finite difference methods and/or the finite volume method. We will use the freely available software Python, since it give us the opportunity to integrate realistic problem solving aspects into classical courses on Advanced Numerical Analysis. This

provides the students with a new dimension for the analysis and understanding of com- plex problems through a methods of numerical approximation and visual representation of the solution. Precisely, the course covers a selection of general purpose numerical methods, both from the mathematical analysis as well as from the practical problem solving aspect.

MMST 812s: Dynamical Systems

Dynamical systems is a vast area and its practitioners include applied mathematicians, analysts and others in science and engineering. Although there are many books on dynamical systems, they are not always accessible to beginning graduate students as they often require extensive mathematical preparation. The main aim of this course is to provide a broad education in the area that is mathematically insightful yet devoid of extensive formalism. The main topic will be a study of the qualitative and geometric theory of dynamical systems. The approach taken will be heavily driven by examples. Students will be introduced to a number of techniques to address several problems in dynamical systems. The students will be provided with fundamental ideas of the subject so that they will poised to take on advanced topics in dynamical systems.

MMST 800s: Project Work (Dissertation)

In the last phase of the programme, students will select projects which they will work on with the supervision of supervisors. A thesis will be submitted at the end of the dissertation phase.