

COURSE NAME: **TECHNIQUES FOR SOLVING ADVANCED
MATHEMATICS PROBLEMS**

COURSE CODE: **MATH3425**

LEVEL: **III**

NUMBER OF CREDITS: **3**

SEMESTER: **I**

PREREQUISITES: **MATH2401: Elements of Mathematical Analysis
MATH2410: First Course in Linear Algebra**

RATIONALE: Problems solving is at the heart of the mathematical experience. All students of mathematics gain at least an ad-hoc set of skills in problem solving. As a focus of mathematics teaching, problem solving is important as it encompasses skills and functions which are important aspects of everyday life, and as a tool can simulate real life experiences.

COURSE DESCRIPTION: In this course, students will build on their knowledge and gain an explicit and systematic understanding of the skills used in solving mathematics problems. The course is designed primarily for students majoring in Mathematics with Education. However, it is also suitable for all mathematics and physics students. The course will entail problem-solving techniques in areas of mathematics including Algebra, Geometry, and Modular Arithmetic.

LEARNING OUTCOMES: On successful completion of the course, the student should be able to:

- Apply advanced techniques in geometry to solve non-routine geometry problems;
- Apply advanced techniques to solve non-routine modular arithmetic problems;
- Apply fundamentally important inequalities to establish new and non-routine inequalities;
- Apply original thinking in solving unique and non-obvious problems.

COURSE CONTENT:

Euclidean Geometry: Triangle theorems, similarity as a problem-solving technique; circle theorems, including the chord-angle theorem and theorems on triangles in a circle; problem-solving techniques using parallel lines on a circle.

Modular Arithmetic: The Principle of Induction as a problem-solving technique; advanced uses of the pigeon-hole principle; divisibility; solving problems with congruencies, and solutions of linear congruencies modulo m .

Algebra: Sums and differences of squares; non-linear systems of equations; the arithmetic-geometric-harmonic inequality; the Cauchy-Schwartz inequality, using pattern and symmetries in solving inequalities; techniques for finding extrema; isoperimetric problems; polygons inscribed and circumscribed in a circle.

TEACHING METHODOLOGY: Teaching will be organized as 39 contact hours of problem-based learning. The hours will be allocated to the three main areas (geometry, modular arithmetic, and algebra) with each area receiving approximately 13 hours of coverage. For each area, students will begin with problems selected to uncover basic but significant ideas and principles. Over time, the main content will be discussed by the class and codified by the lecturer. Then the students will solidify their understanding by tackling problems whose solutions show the general principles in action. Finally, each topic will culminate in a written assignment challenging students to solve significant problems in that area. Assignments will be done in small groups based on specified area where each group will be expected to make a presentation, following by an interactive class discussion. All course materials will be posted on the course website, currently supported by OurVLE.

ASSESSMENT

The course assessment has two components:

Three group presentations (one for each content area, weighted 15% each)	45%
One written final examination paper (2 hours)	55%

REFERENCE MATERIALS:

Books:

Prescribed:

1. Krusemeyer M, and Loren C, 2012, *A Mathematical Orchard*, Mathematical Association of America ISBN: 9780883858332

Highly Recommended

2. Polya, G, 2004, *How to Solve it*, Princeton Science Library, ISBN-13: 978-0691119663
3. MahajanS, 2010, *Street Fighting Mathematics: The Art of Educated Guessing and Opportunistic Problem Solving*, The MIT Press, ISBN-13: 978-0262514293

Online Resources:

1. http://gse.berkeley.edu/Faculty/AHSchoenfield/Schoenfield_MathThinking.pdf A good summary of the current research in the pedagogy of problem solving by one of the leading theoreticians.
2. <http://math.about.com/od/1/a/problemsolv.htm> A good reference for future teachers. It has many links to problem sets suitable for students in each grade.
3. <http://myspot.mona.uwi.edu/mathematics/> This is the home of the Jamaican Mathematical Olympiad and the Junior Mathematical Olympiad. It features a good selection of problems suitable for primary and high school students in Jamaica.