TAMALPAIS UNION HIGH SCHOOL DISTRICT
Larkspur, California

Course of Study
Topics in Modern Mathematics 1-2

I. INTRODUCTION

Topics in Modern Mathematics is a course designed for the student who has completed Advanced Algebra and is in the 11th or 12th grade. This course will meet the third year requirement or beyond for all students who have taken the prerequisite mathematics classes. The course will be offered in two discrete semesters; students will have the option of enrolling in the fall semester, the spring semester, or both semesters. The purpose of this course is to convey the power of mathematics by showing the great variety of problems that can be modeled and solved by quantitative means, and to appeal to the "liberal arts" student who may wish to take a course in something other than precalculus or statistics. *Topics in Modern Mathematics* is designed to make mathematics accessible and understandable to a diverse student population, challenging both gifted students and providing access to a rich set of topics for all students. While designed as an offering for students with preparation through advanced algebra, the course will also be interesting and desirable to students who have taken or are taking precalculus, calculus, or statistics. This course will not have overlapping topics with the aforementioned courses; it will consist of topics that are not traditionally taught in the college preparatory sequence (algebra, geometry, advanced algebra). This course is designed to give students the opportunity to work with concepts and topics in applied mathematics fields. In science and industry, mathematical models are the main tools for analyzing and solving problems that arise; this course will give students some insight into the excitement of contemporary mathematical thinking.

The goals of this course are to provide students with a course that encompasses a technological element, research element, artistic element, and an analytical component while broadening student understanding of what modern mathematics is. In *Topics in Modern Mathematics*, a primary goal will be to emphasize mathematical modeling with rich problem situations that promote mathematical thinking. The full use of graphing calculators and the computer will permit student learning to focus on mathematical thinking and reasoning as well as gaining access to the mathematics of modern times. This course will emphasize the broad view of the world using mathematics as a lens. The semester courses will fall under three umbrella themes: Mathematics and Decision Making, Spatial Visualization, and The Digital Revolution. Teachers will provide an historical component that complements the topics being taught.

This course addresses the following Tam 21st Century goals:
INSTRUCTION: to provide a program, which prepares students for graduation and provides opportunities for student growth, development, and post-secondary options.
STUDENTS: to provide an environment, which supports academic, social and emotional growth and success and opportunities for student choice.

This course is consistent with the Tam 21st Century Mission:
Students will have opportunities to:

- acquire, manage and use knowledge and skills
- think critically and creatively
- prepare for participation in a rapidly changing global community

From the Tam 21st Century Philosophy:

- provide equity of opportunity for all students
- provide access to alternate educational opportunities

II. STUDENT LEARNING OUTCOMES

This course addresses the following Student Learning Outcomes:

1. Communicate articulately, effectively, and persuasively when speaking and writing.
2. Read and analyze material in a variety of disciplines.
3. Use technology as a tool to access information, analyze and solve problems, and communicate ideas.
5. Apply mathematical knowledge and skills to analyze and solve problems.
10. Analyze and propose solutions to contemporary issues using a variety of perspectives

A. Students will:
Under the umbrella of *Mathematics and Decision Making, there are two main themes: voting and social science is one, and management science is the other*.

1. Understand a variety of voting methods and apply the different voting methods in appropriate ways and in appropriate situations. Inclusive in this are the lessons on determining a "fair vote" and weighing the pros and cons of each voting method.
2. Learn the Methods of Fair Division. Incorporated into these lessons will be the Divider-Chooser, Lone-Divider, Lone Chooser, Last Diminished, Sealed Bids, and Marker methods of division.
3. Understand the different types of Apportionment and learn how they have effected elections, structured government, influenced history, and in what way they continue to have social repercussions.
4. Connect situational problems to Euler Circuits, Hamiltonian Circuits, Networks, Digraphs, graph models, and spanning trees.
5. Apply algorithms (Fleury, Brute-Force, Nearest Neighbor, Repetitive Nearest Neighbor, Cheapest Link, Kruskal, Shortest Distance, Decreasing Time, Critical Path) to graph models, digraphs, or spanning trees in order to find optimal solutions.
6. Represent business models, resolve conflicts, and explore business efficiency using circuits, digraphs, optimal paths, and coloring techniques.

Under the umbrella of *Spatial Visualization*:

7. Investigate the geometry of our planet Earth (spherical or non-Euclidean geometry) using the Lenart Sphere; compare and contrast relationships on the sphere with corresponding relationships on flat surfaces.
8. Gain deeper insight into the traditional geometry of flat surfaces (the plane) while increasing spatial visualization skills.
9. Investigate the geometry of natural shapes called Fractal Geometry.
10. Conceptualize the building blocks of fractal geometry through the use of recursive replacement rules and self-similarity.
11. Illustrate recursive replacement rules and self-similarity using the Koch Snowflake, the Sierpinski Gasket, Chaos Game, the Mandelbrot Set, the Twisted Sierpinski Gasket, and any other appropriate model.
12. Explore the self-similarity idea in art and literature, and examine a variety of symmetries used in art and mathematics.

Under the umbrella of *The Digital Revolution*:

13. Analyze the mathematics of assigning identification numbers and their social implications. (routing numbers, UPC bar codes, social security, personal data, and passwords)
14. Investigate the methods of encoding and embrace the challenges that mathematicians face when attempting to transmit data securely.
15. Strengthen understanding of the process used in correcting errors in data transmission and how to send and store information economically.
16. Explore the variety of methods used to encode information. This may include binary codes, Huffman, Delta, and Boolean encoding methods.
17. Apply the process of encrypting data to make or break secret codes. Modular mathematics, Boolean logic, and public and private key methods will be an integral component of cryptography.
18. Relate the development of different number systems throughout history to society's current need for a variety of number representations.

B. There are no current State of California content standards covered in this course. Students may cover all of the content standards in the other courses offered by the mathematics department.

C. There are no current content standards covered in this course that will prepare students specifically for the High School Exit Exam or the Content Standards Exams. Students will, however, have the opportunity to broaden their repertoire of problem solving strategies and expand their ability to think mathematically; this, in turn, will help them through their exams. Opportunities to cover all of the content standards are provided in courses offered by the mathematics department.

III. ASSESSMENT

A. Student Assessment

1. Students will be assessed primarily through projects and class participation.
2. Differentiated assignments will be encouraged for the varying levels of student achievement.
3. Students, with guidance from their teacher, will develop rubrics for grading projects.
4. A research component will be assigned each semester, based on the interest of the student and the topics covered.
5. An artistic project with mathematical connections will be assigned in each semester. Students will have a choice in which medium they display their work.

B. Course Assessment

This course will be assessed by student feedback given in a pre- and post- survey. The number of students who enroll in this course by semester will also be a measure of its success.

IV. METHODS AND MATERIALS

A. Methods

Students will learn through class discussions, research, problem sets, and projects. Students will work in collaborative groups, in pairs, or alone while focusing on problems, situations, or mathematical models. The teacher will act as an intellectual coach while informally assessing, correcting, extending, and modeling understanding of modern mathematics. The teacher will also moderate class discussions, suggest "outside reading" to further learning, and provide opportunities for students to gain understanding of the concepts developed under the three umbrella themes.

B. Materials

In addition to the course approved textbook, this course requires two different material components. On the technological side, applets, graphing calculators, Geometer's Sketchpad, and the library media center will be integral for instruction delivery and learning. On the supplemental side, the well-equipped classroom will also have a class set of books to complement the course approved text, three copies of The Mathematical Tourist by Ivars Peterson, a subscription to *The Mathematics Teacher*, and the publisher's resource package.

This course uses the following Board-approved textbooks and supplementary books:

- Excursions in Modern Mathematics, by Peter Tannenbaum, Pearson Prentice Hall, 2006
- For All Practical Purposes; COMAP, W.N. Freeman & Comp, 2006

C. Technology

The graphing calculator, the internet, LCD projector, the Geometer's Sketchpad, and computers will be used. Students may choose to use other devices in individual projects, depending on the topic chosen.

D. School to Career Goals

This course has many opportunities to tie the mathematics to career experiences. Two of the three umbrella themes (Mathematics and Decision Making and The Digital Revolution) are directly related to the world of work. We will work closely with the school to career liaison to coordinate appropriate speakers, job shadows, and field trips.

E. Suggested Instructional Time Allocation

Based on the differing lengths of semesters, the first semester topics covered should be all of the content described under the Mathematics and Decision Making theme. Semester two will cover the Spatial Visualization and The Digital Revolution topics.

V. GENERAL INFORMATION

Topics in Modern Mathematics consists of two "stand alone" semester courses, each worth five credits, open to students who have completed Advanced Algebra and are in the 11^{th} or 12^{th} grade

A. Prerequisites

Students have to have completed Advanced Algebra with a grade of C- or better, and must be in the 11^{th} or 12^{th} grade.

B. Requirements Met

This course may be used in partial fulfillment of the mathematics graduation requirement.

This course is accepted in partial fulfillment of the UC/CSU "c" admissions requirement in mathematics.

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