Ohio's Fourth-Year *Modeling and Quantitative Reasoning* Course

Rationale: One purpose of secondary education in the United States has always been preparing students for their roles as citizens, as well as preparing them for future study and the workplace. Today numbers and data are critical parts of public and private decision making. Decisions about health care, finances, science policy, and the environment are decisions that require citizens to understand information presented in numerical form, in tables, diagrams, and graphs. Students must develop skills to analyze complex issues using quantitative tools.

In addition to a textbook, teachers will want to use on-line resources, newspapers, and magazines to identify problems that are appropriate for the course. Students should be encouraged to find issues that can be represented in a quantitative way and shape them for investigation. Appropriate use of available technology is essential as students explore quantitative ways of representing and presenting the results of their investigations.

Course Description: This course prepares students to investigate contemporary issues mathematically and to apply the mathematics learned in earlier courses to answer questions that are relevant to their civic and personal lives. The course reinforces student understanding of
- percent
- functions and their graphs
- probability and statistics
- multiple representations of data and data analysis

This course also introduces functions of two variables and graphs in three dimensions. The applications in all sections should provide an opportunity for deeper understanding and extension of the material from earlier courses. This course should also show the connections between different mathematics topics and between the mathematics and the areas in which applied.

Student projects should be incorporated throughout the course to explore data and to determine which function best represents the data. These projects may be done individually or in groups and should require collecting data, analyzing data and presenting the results to the class. Technology will be an important tool for students to use in their investigations of the data and in their presentations of results and predictions to the class. Such projects require all students to be actively involved and help them become independent problem solvers.

Topic List

4M.1 – Use of Percent
The mathematics includes deepening the student understanding of percentages and the uses and/or misuses in business, media, school, and consumer applications. Include exploration of the effects of compounding the percentages in these applications.
- Percentages used as fractions, to describe change, and to show comparisons (e.g., sale prices, inflation, cost of living index and other indices, tax rates, and medical studies).
- Compound percents used in financial applications (e.g., savings and investments, loans, credit cards, mortgages, and federal debt).

4M.2 – Statistics and Probability
The mathematics in this unit includes an extension of the statistics and probability topics previously covered in the model.
- The Probability section includes systematic counting, simple probability, combining probabilities in problem situations, conditional probability and the difference between odds

and probability (e.g., insurance, lottery, backup systems, random number generator, weather forecasting, and data analysis).
- The Statistics section includes collecting, organizing, and interpreting data (e.g., margin for error, sampling bias within surveys and opinion polls, correlation vs. causation).

4M.3 – Functions and Their Graphs
This unit forms the core of the course. The mathematics includes reviewing functions that students have previously studied and using the functions and their graphs to analyze familiar but complex problem settings.
- Linear functions describe constant rates of change, unit conversions, linear regressions, and correlation. Many applications can be illustrated (e.g., gas bills, temperature unit conversions, hourly wage, straight line depreciation, and simple interest).
- Exponential functions model many problems from school, work and consumer settings (e.g., population growth, radioactive decay, inflation, depreciation¸ periodic drug doses, and trust fund). The concepts of " doubling time" and " half life" should be included.
- Logarithmic functions, their graphs, and logarithmic scales describe data from familiar problem settings (e.g., real population growth, investment time, earthquakes, and noise levels).
- Periodic functions include trigonometric functions and introduce the concept of cyclic behavior (e.g., sound waves, amount of sunlight per day over days of a year, behavior of springs).
- Exponential and trigonometric functions can be combined by considering damped harmonic motion (e.g., motion of a bouncing ball or spring when friction is considered).

4M.4 – Functions of More Than One Variable
The mathematics curriculum in grades 9–12 generally focuses on functions of one variable. Real world applications, however, often require consideration of more than one variable. This unit provides opportunities for students to work with functions of more than one variable.

Most problem settings in this unit will be represented by functions of two variables so that students can represent data with graphs in three dimensions (e.g., topographic maps, car loans, weather maps with colors representing temperature ranges, and other 3-dimensional media graphics).

4M.5 – Geometry
The mathematics in this unit reviews the basics of Euclidean geometry and uses properties of solid geometry to model and solve problems in three dimensions. Two-dimensional geometry is extended using vectors and linear transformations. Fractal geometry is introduced and explored.
- Problem solving in this section will include dimension, surface area, volume, and measurement of angles in three-dimensions (e.g., capacity, surface areas in consumer applications, latitude, longitude, and optimization problems). The solid geometry can be extended to equations of planes and lines in 3-space.
- Use vectors as a tool to describe the geometry leading to linear transformations of plane figures and compare areas (e.g., animation in graphic design).
- Fractal geometry is introduced by defining fractal dimensions and using this dimension and iteration in problem solving situations in nature (e.g., measuring an island coast line, the length of meandering stream, area of a square leaf with holes in a fractal pattern or the volume of a cube cut from a rock that contains cavities forming a fractal pattern).