Canyon Crest Academy: Advanced Math for Decision Making

Level of Difficulty	Estimated Homework	Prerequisites
☐ Moderate ☒ Difficult ☐ Very Difficult	30-60 minutes	**District** **Department** C test average in Integrated Math 3 or Integrated Math 3 Honors

Course Description

The field of operations research involves the development of mathematical models to improve decision making at both the strategic and operational levels. The course teaches practices of operations research. It has broad applicability in industry and government and can also assist in making personal decisions.

Throughout the course we will spend our time developing, solving, and analyzing mathematical models for decisions in relevant, real-world contexts. We will tackle realistic problems, which are typically large and complex. Appropriate technologies including spreadsheets and the graphing calculator will be utilized.

Below are some guidelines for choosing the best course for an individual student. This is *not* a placement test and it should *not* be used as the only criteria for making placement decisions.

Student Background

Students entering **Advanced Math for Decision Making** should have a good understanding of the following concepts:

- Understanding properties of linear functions.
- Graphing and describing features of linear functions.
- Defining variables and using them to model relationships among quantities.
- Knowing the basic concepts of probability.
- Solving real-world problems using mathematical models and interpreting the results.

Students entering **Advanced Math for Decision Making** should also be able to solve problems such as:

Probability Problem:	Equation Problem:
The probability of Event A is 0.45 and the probability of Event B is 0.8. Event A and Event B are independent events. Determine each probability: a) $P(A \text{ and } B)$ b) $P(A \text{ or } B)$ c) $P(\text{ not } B)$	Solve the equations to determine the point of intersection: $x + 3y = -4$ $5x - 2y = 6$

Word Problem:

A business is open from 7 AM to 5 PM and has eight employees that can work in three hour shifts. If the business needs at least two employees at a time before noon and at least three employees after noon, devise a possible work schedule that is cost effective. Assume all employees earn equal pay.

Course Content and Expectations

In **Advanced Math for Decision Making**, students will learn the following concepts:

Multi-Criteria Decision Making
Some decisions involve comparing alternatives that have strengths or weaknesses with regard to multiple objectives of interest to the decision maker. For example, your objectives in buying health insurance might be to minimize cost and maximize protection. Sometimes multiple objectives like these get in each other's way. Multi-criteria decision making is a structured methodology designed to handle the tradeoffs among multiple objectives.

Mathematical Programming: Mathematical programming is a method of modeling a decision context using a system of linear inequalities representing constraints and a linear function representing the objective of the decision. Mathematical programming is relevant when there is a single objective to be optimized. For example, a model can be developed to decide about which mix of products to manufacture to maximize profits. More applications are possible when the possible values of the decision variables are limited to the integers or even further restricted to zero and one. Solving mathematical programming problems requires long and tedious matrix calculations, so we will use a spreadsheets and specialized software to find optimal solutions to our models.

Sensitivity Analysis: A great deal of time and energy will be spent interpreting the results of our mathematical models. We will investigate how changes in the parameters of the problem affect the optimal solution and the optimal value of the objective function. This interpretation and analysis will always be tied to the real-world context of the problem.

Basic Probability and Randomness: We will strive to develop a better understanding of random patterns through the use of simulated experiments. Physical simulations and electronic random number generators will be used for simulate different types of events. Basic concepts and notation of probability and sets will be introduced.

Conditional Probability: People have notoriously poor intuition about conditional probability (i.e., the probability that an event will occur given that a different event also occurs). We will develop concepts related to conditional probability through analyzing data, problem contexts, and partitions of sets. This will eventually lead to a more formal definition of conditional probability and related formulas.

Decision Trees: Decision trees provide a structure for determining the alternative that optimizes the expected value. The decision tree also provides the probability distribution for each of the alternatives.

Binomial and Geometric Distributions: The concept of a probability distribution function is introduced. When repeated random events follow the same assumptions, there may be a formula that summarizes the probabilistic pattern. This formula will have parameters whose values vary from context to context. The binomial probability distribution calculates the probability of a certain number of successes in a given number of trials. The geometric distribution tracks the number of repetitions until the first success.

Poisson Distribution: The Poisson distribution is used to characterize a probabilistic environment in which random events occur totally independent of one another. The distribution is used to estimate the probability that there will be X events in a unit of time.

Normal Distribution: The Normal distribution is used to describe a continuous random variable with a mean of μ and a standard deviation of σ. The sum of identically distributed independent random variables is known to approach the normal distribution. For that reason, the randomness of the sample average of a random variable can be approximated with the normal distribution.

<u>Grading</u>

There will be regularly scheduled homework assignments, quizzes, and exams.

Syllabus Link

Supplemental Information
10 Credits
Meets high school graduation requirement for math or electives
Meets UC/CSU subject area “c” requirement