Comprehensive Course Syllabus

Course Title
Discrete Mathematics

Course Description:
Discrete Mathematics is a one semester elective course dealing with the study of topics that are based on concepts in mathematics that can, in some manner, be divided into "separate" or "discontinuous" (and thus, discrete) parts. The purpose of the course is to provide students with a sampling of content from this branch of mathematics. Major areas of mathematical content addressed can include social applications and decision making, techniques of counting, probability, Pascal-type triangles and their connection to other mathematical content, graph theory, algorithm development, pattern generation and recognition, and modeling.

INSTRUCTOR(S):

- Name(s): Dr. Donald Porzio
- Office Number(s) (When and where you are available for help.): A157
- Telephone number(s): 630-907-5481
- Email address(es): dporzio@imsa.edu

- Office Hours
  A Days: 8:30-8:50, 10:00-11:00, 2:45-3:10, 4:15-4:30
  C Days: 7:50-8:50, 10:00-10:20, 2:45-3:10, 4:15-4:30
  D Days: 8:30-8:50, 10:00-10:20, 2:10-3:10, 4:15-4:30
  or by appointment if you really need to meet with me at a specific time.

Meeting Days, Time and Room(s)
A, C and D Days, 9:00 – 9:55 am (mod 2), A155
A, C and D Days, 3:20 – 4:15 pm (mod 8), A155

Text(s) / Materials:
No text required. Students will receive a series of teacher generated handouts. Students are expected to maintain a notebook containing class notes, homework assignments, quizzes, and other handouts. Students are also expected to bring a graphing calculator to class each day (TI-89 Titanium preferred, TI-89, TI-83/84 are okay).

Essential Content:

Mathematics Team Learning Standards targeted (formally assessed) or addressed in this course include:

Standard A – Students studying mathematics at IMSA demonstrate a disposition and propensity to use mathematics, a variety of problem solving strategies, and creative thought to solve problems by:

1. investigating and gaining insight into mathematical concepts by selecting and using a variety of traditional and creative problem solving strategies and methodologies. *Targeted*
3. interpreting, generalizing, and verifying the understanding gained in the problem solving process and extending it to new settings. *Addressed*
4. using a variety of resources and problem solving approaches. *Targeted*
5. demonstrating confidence, persistence, and reflective analysis of the effectiveness of an approach when attempting to solve a problem. *Addressed*

Standard B – reason logically in mathematical situations and understand the nature, role, and necessity of proof and counterexample in mathematical reasoning by:

2. reasoning inductively and deductively. *Targeted*
3. making and testing conjectures, creating proofs, and identifying counterexamples. *Targeted*
4. enhancing inductive and deductive reasoning through the use of intuition, imagination, and other forms of reasoning. *Addressed*
6. understanding the role of logic in the development of mathematics and understanding the necessity of carefully proving assertions. *Addressed*

Standard C – Students studying mathematics at IMSA communicate clearly and accurately about mathematical relationships and results by:

1. understanding mathematical information given in written, oral, symbolic, numeric, or graphic form and interpreting the relationship it represents. *Targeted*
2. accurately recording and effectively communicating using proper notation, vocabulary, and usage in a variety of modalities (written, oral, graphic, algebraic, etc.). *Targeted*

Standard D – Students studying mathematics at IMSA demonstrate awareness of the inter-connectedness of mathematical thought in inter- and intra-disciplinary settings by:

1. understanding that mathematics is a system of interconnected ideas. *Addressed*

Standard E – Students studying mathematics at IMSA understand and employ the power, economy, clarity, and elegance of mathematical representations by:

1. recognizing that mathematical representations carry specific meanings and using mathematical notation correctly to enhance clarity and avoid ambiguity. *Targeted*
2. applying a variety of techniques to compare and manipulate mathematical representations.. *Targeted*

Standard F – Students studying mathematics at IMSA use and interpret appropriate mathematical models to represent real-world situations by:

1. choosing an appropriate representation or mathematical model for a given situation. *Targeted*
4. interpreting mathematical results in terms of the situation modeled.. *Targeted*

Standard K – Students studying mathematics at IMSA understand and apply discrete mathematical models by:

1. using matrices, sequences, and their operations to model phenomena. *Targeted*
2. analyzing and interpreting situations using recursive thinking and inductive reasoning.. *Targeted*
3. creating and interpreting directed graphs and networks. *Targeted*
4. demonstrating an understanding of basic counting principles and the situations under which they may be applied.. *Targeted*

Standard L – Students studying mathematics at IMSA demonstrate awareness of the inter-connectedness of mathematical thought in inter- and intra-disciplinary settings by:

2. using technology to facilitate doing, exploring, and understanding of mathematics. *Addressed*

These standards will be addressed in *Discrete Mathematics* through the study of:

- social applications and decision making (e.g., methods for determining the winner of an election)
- permutations and combinations
- binomial and multinomial coefficients
- Pascal-type triangles and their connection to other mathematical content
- sequences and series
- figurate numbers
- graph theory (including basic components in graphs, applications of walks and circuits in graphs, graph coloring, and search and spanning trees)
- algorithm development
- pattern generation and recognition in a variety of contexts
- modular math
- mathematical modeling

SSLs and Outcomes:
IMSA SSL(s) and outcomes targeted (formally assessed) or addressed in this course include:

SSL I – Developing the Tools of Thought:

A. Develop automaticity in skills, concepts, and processes that support and enable complex thought. *Targeted*

B. Construct questions which further understanding, forge connections, and deepen meaning. *Addressed*

D. Evaluate the soundness and relevance of information and reasoning. *Targeted*

SSL III – Extending and Integrating Thought

A. Use appropriate technologies as extensions of the mind. *Targeted*

B. Recognize, pursue, and explain substantive connections within and among areas of knowledge. *Targeted*

C. Recreate the beautiful conceptions that give coherence to structures of thought. *Addressed*

SSL IV – Expressing and Evaluating Constructs

A. Construct and support judgments based on evidence. *Targeted*

B. Write and speak with power, economy, and elegance. *Addressed*

Instructional Design and Approach:
The instructional design of *Discrete Mathematics* provides opportunities for students to work collaboratively on a regular basis both in and out of class. Collaboration encourages oral communication, multiple perspectives in problem solving, and self regulation. Carefully crafted and sequenced questions, problems, and explorations comprise our problem-centered curriculum, which enables learning through guided discovery. This process requires pattern recognition, mathematical reasoning and visualization, critical thinking, appropriate use of technology and use of multiple representations in building connections within and between mathematical concepts. Throughout the course, there is a focus on learning through a constructivist approach. Patterns are used to clarify the major ideas and concepts. Considerable time is spent making connections among the concepts and ideas studied, while emphasizing the "discrete" nature of the content. Regular teacher feedback and ongoing assessment shapes the learning experience for each individual student. The teacher's informal assessment of each student and the class as a whole tailors instruction to immediate need, generates enthusiasm, and insures intended connections. In addition, students are expected to communicate their understandings in writing with clarity, coherence, and mathematical accuracy. Also integral to the core experience are unique classroom investigations that are intermittently incorporated to introduce students to mathematical inquiry, stretching their understandings in new directions. As a result of this carefully structured learning experience, students' abilities to engage in mathematical inquiry, pose questions, and communicate mathematical concepts evolve, inviting creativity in problem solving, application, and further collaboration.

Student Expectations:
All students are expected to:

- adhere to IMSA's Academic Behavior Code, as described in the IMSA Student Handbook.
- participate in class discussions and explorations, both large and small group.
- maintain a notebook containing class notes, homework assignments, quizzes, and other handouts.
- complete all daily assignments, homework assignments, and project(s) in a timely manner.
- come prepared for each class. (If you come to class unprepared, you not only deprive yourself, but you also deprive the other students at your table, and, in fact, the entire class.)
- take responsibility for learning certain basic skills and relationships.
- take responsibility for seeking additional help as it is needed.
- have a graphing calculator with them during each class.
- treat others with respect and politeness, to keep a sense of adventure (and humor), to have patience, and to be willing to try new stuff!

Assessment Practices, Procedures, and Processes:

- ***Daily worksheets***. This work forms the basis for explorations, discussions, and homework. Though these assignments are not be collected, the expectation is that they will be completed in a timely manner, either by the end of that class or the beginning of the next class, so that everyone can contribute to the class discussion on the material.
- ***Homework.*** Typically, one of these assignments is given each week, with students being given 3 to 7 days to complete them. They include problems (and possibly reading assignments) taken from a variety of sources. Often time is given during class to work on these assignments. If a homework assignment is turned in late without prior approval of the instructor, then there will be a 10% to 100% reduction in points, depending upon just how late the assignment is turned in.
- ***Quizzes.*** These are given two or three times each quarter, typically take between 35-50 minutes, will, on occasion, be done in groups or pairs, and will, on occasion, involve the student generating a note card for use during the quiz.
- ***Projects.*** Some semesters, students may be assigned a project where they are to explore some Discrete Mathematics topic not discussed in class or some connection of Discrete Mathematics to the" real world".

Quarter and Semester grades will be averaged using the following weightings:

Quizzes/Quests/Tuizzes	67%
Homework	33%

Grading scale:

A - 90% or above
B - 80% or above but less than 90%
C - 70% or above but less than 80%
D - less than 70% (*no one* should have a score in this range!)

Sequence of Topics and Activities

- Introductory Discrete Mathematics activity (varies from semester to semester) – 2 class meetings
- Voting Theory: methods for determining winner of an election – 2 class meetings
- Voting Theory: Arrow's Impossibility Theorem – 1 class meeting
- Factorial problems, Binomials and Multinomial Coefficients – 3 class meetings
- Series review, Binomial Coefficients and their relationship to Pascal's Triangle, relationships within Pascal's Triangle – 2 to 3 class meetings (and then off and on throughout the semester)
- Polygonal and Polyhedral Numbers – 2 to 3 class meetings
- Graph Theory: Euler's Formula relating vertices, edges and faces– 1 class meeting
- Graph Theory: an introduction – 3 class meetings
- Graph Theory: Eulerian walks and circuits, Hamiltonian paths and cycles – 3 class meetings
- Graph Theory: Eulerian walks and circuits, Hamiltonian paths and cycles in directed graphs – 2 class meeting
- Graph Theory: Graph coloring – 2 class meetings
- Graph Theory: Trees (including search tree algorithms, spanning trees, weighted trees, greedy algorithms – 4 class meetings
- Varied (famous) Discrete Mathematics problems (e.g., the Josephus problem, the Hats Problem) – 3 class meetings
- Poker and Blackjack hand probabilities – 4 class meetings
- Voting Theory: Power Indexes as applied to Coalition Voting – 2 class meetings
- Modular Mathematics – 3 class meetings
- Graph Theory: Program Evaluations and Review Technique – 2 class meetings
- Miscellaneous Topics (M–ominoes, 2D and 3D Billard Ball Mathematics, Game of Sprouts) – 3 class meetings