SYLLABUS FOR MATH 1060
Mathematics of Decision Making

This is a course on the mathematics involved in decision making, scheduling, voting strategies, apportionment, and related ideas of game theory and "the digital revolution," encryption and identification systems. Critical thinking skills, counting principles (chapters 2 and 11), and quantitative reasoning should be emphasized at the appropriate points (chapter 14).

Approximately two-thirds of the course should be based on the topics of graph theory and scheduling (chapters 1–3), voting strategies (chapters 9–11), and fair division and apportionment (chapters 13–14). The remaining one-third of the course can be devoted to topics of interest to the instructor and students, chosen from chapters listed below.

<u>Text</u>: *For All Practical Purposes: Mathematical Literacy in Today's World*, seventh edition, W. H. Freeman and Co., 2006.

Required Topics

(1) Management Science and Graph Theory
   (a) Chapter 1: Urban Services: graphs, finding Euler circuits, "Eulerizing" a graph.
   (b) Chapter 2: Business Efficiency: Hamiltonian circuits, fundamental counting principles (basic combinatorial notions), sorted-edges algorithm, Kruskal's algorithm and minimum-cost spanning trees. Applications to routing long-distance telephone calls. Critical path analysis.
   (c) Chapter 3: Planning and Scheduling: List-processing algorithm, critical-path scheduling, decreasing-time-list algorithm. Graph coloring and applications to scheduling exams.
(2) Voting and Social Choice
   (a) Chapter 9: Social Choice: The Impossible Dream: Majority rule and Condorcet's method, voting systems with more than two candidates, sequential pairwise voting, Hare system. Arrow's impossibility theorem, approval voting.
   (b) Chapter 10: The Manipulability of Voting Systems: Manipulability of the different voting systems, Gibbard-Satterthwaite Theorem.
   (c) Chapter 11: Weighted Voting Systems: Shapley-Shubik and Banzhaf power indices, permutations and combinatorial reasoning. Comparing voting systems, winning coalitions.
(3) Fairness and Apportionment
   (a) Chapter 13: Fair Division: Adjusted winner allocation, Knaster inheritance procedure, taking turns, divide-and-choose. Cake division procedures: proportionality and envy.
   (b) Chapter 14: Apportionment: Apportionment methods, quotas. Congressional apportionment: Hamilton's method, Jefferson's method, divisor methods, Webster's method, Hill-Huntington method. What's fairest?

Remaining Topics (choose two)

(4) Chapter 4: Linear Programming: Feasible region, optimal production policy, simplex method, tableaux.
(5) Chapter 15: Game Theory: The Mathematics of Competition: Winning strategies, maximin and minimax strategies. Zero-sum and variable-sum games. Prisoners' Dilemma, chicken. Winning games.
(6) Chapter 16: Identification Numbers and Chapter 17: Information Science: Check digits, bank ID and ISBN numbers, UPC bar codes. Binary codes, parity-check sums, data compression. Cryptography, public-key cryptography and modular arithmetic, RSA encryption. Boolean logic.