

Discrete Mathematics

Adopted 2013

Mathematical process standards

- 1. The student uses mathematical processes to acquire and demonstrate mathematical understanding** DMPS.9-12.1

 - (A) apply mathematics to problems arising in everyday life, society, and the workplace** DMPS.9-12.1.A

 - (B) use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution** DMPS.9-12.1.B

 - (C) select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems** DMPS.9-12.1.C

 - (D) communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate** DMPS.9-12.1.D

 - (E) create and use representations to organize, record, and communicate mathematical ideas** DMPS.9-12.1.E

 - (F) analyze mathematical relationships to connect and communicate mathematical ideas** DMPS.9-12.1.F

 - (G) display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication** DMPS.9-12.1.G

Graph theory

- 2. The student applies the concept of graphs to determine possible solutions to real-world problems** DMPS.9-12.2

 - (A) explain the concept of graphs** DMPS.9-12.2.A

 - (B) use graph models for simple problems in management science** DMPS.9-12.2.B

 - (C) determine the valences of the vertices of a graph** DMPS.9-12.2.C

 - (D) identify Euler circuits in a graph** DMPS.9-12.2.D

 - (E) solve route inspection problems by Eulerizing a graph** DMPS.9-12.2.E

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- (F) determine solutions modeled by edge traversal in a graph** DMPS.9-12.2.F

 - (G) compare the results of solving the traveling salesman problem (TSP) using the nearest neighbor algorithm and using a greedy algorithm** DMPS.9-12.2.G

 - (H) distinguish between real-world problems modeled by Euler circuits and those modeled by Hamiltonian circuits** DMPS.9-12.2.H

 - (I) distinguish between algorithms that yield optimal solutions and those that give nearly optimal solutions** DMPS.9-12.2.I

 - (J) find minimum-cost spanning trees using Kruskal's algorithm** DMPS.9-12.2.J

 - (K) use the critical path method to determine the earliest possible completion time for a collection of tasks** DMPS.9-12.2.K

 - (L) explain the difference between a graph and a directed graph** DMPS.9-12.2.L
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Planning and scheduling

- 3. The student uses heuristic algorithms to solve real-world problems** DMPS.9-12.3

 - (A) use the list processing algorithm to schedule tasks on identical processors** DMPS.9-12.3.A

 - (B) recognize situations appropriate for modeling or scheduling problems** DMPS.9-12.3.B

 - (C) determine whether a schedule is optimal using the critical path method together with the list processing algorithm** DMPS.9-12.3.C

 - (D) identify situations appropriate for modeling by bin packing** DMPS.9-12.3.D

 - (E) use any of six heuristic algorithms to solve bin packing problems** DMPS.9-12.3.E

 - (F) solve independent task scheduling problems using the list processing algorithm** DMPS.9-12.3.F

 - (G) explain the relationship between scheduling problems and bin packing problems** DMPS.9-12.3.G
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Group decision making

- 4. The student uses mathematical processes to apply decision-making schemes. The student analyzes the effects of multiple types of weighted voting and applies multiple voting concepts to real-world situations** DMPS.9-12.4

- (A) describe the concept of a preference schedule and how to use it** DMPS.9-12.4.A

- (B) explain how particular decision-making schemes work** DMPS.9-12.4.B

- (C) determine the outcome for various voting methods, given the voters' preferences** DMPS.9-12.4.C

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- (D) explain how different voting schemes or the order of voting can lead to different results** DMPS.9-12.4.D

 - (E) describe the impact of various strategies on the results of the decision-making process** DMPS.9-12.4.E

 - (F) explain the impact of Arrow's Impossibility Theorem** DMPS.9-12.4.F

 - (G) relate the meaning of approval voting** DMPS.9-12.4.G

 - (H) explain the need for weighted voting and how it works** DMPS.9-12.4.H

 - (I) identify voting concepts such as Borda count, Condorcet winner, dummy voter, and coalition** DMPS.9-12.4.I

 - (J) compute the Banzhaf power index and explain its significance** DMPS.9-12.4.J
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Fair division

- 5. The student applies the adjusted winner procedure and Knaster inheritance procedure to real-world situations** DMPS.9-12.5

 - (A) use the adjusted winner procedure to determine a fair allocation of property** DMPS.9-12.5.A

 - (B) use the adjusted winner procedure to resolve a dispute** DMPS.9-12.5.B

 - (C) explain how to reach a fair division using the Knaster inheritance procedure** DMPS.9-12.5.C

 - (D) solve fair division problems with three or more players using the Knaster inheritance procedure** DMPS.9-12.5.D

 - (E) explain the conditions under which the trimming procedure can be applied to indivisible goods** DMPS.9-12.5.E

 - (F) identify situations appropriate for the techniques of fair division** DMPS.9-12.5.F

 - (G) compare the advantages of the divider and the chooser in the divider-chooser method** DMPS.9-12.5.G

 - (H) discuss the rules and strategies of the divider-chooser method** DMPS.9-12.5.H

 - (I) resolve cake-division problems for three players using the last-diminisher method** DMPS.9-12.5.I

 - (J) analyze the relative importance of the three desirable properties of fair division: equitability, envy-freeness, and Pareto optimality** DMPS.9-12.5.J

 - (K) identify fair division procedures that exhibit envy-freeness** DMPS.9-12.5.K
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Game (or competition) theory

6. The student uses knowledge of basic game theory concepts to calculate optimal strategies. The student analyzes situations and identifies the use of gaming strategies DMPS.9-12.6

(A) recognize competitive game situations DMPS.9-12.6.A

(B) represent a game with a matrix DMPS.9-12.6.B

(C) identify basic game theory concepts and vocabulary DMPS.9-12.6.C

(D) determine the optimal pure strategies and value of a game with a saddle point by means of the minimax technique DMPS.9-12.6.D

(E) explain the concept of and need for a mixed strategy DMPS.9-12.6.E

(F) compute the optimal mixed strategy and the expected value for a player in a game who has only two pure strategies DMPS.9-12.6.F

(G) model simple two-by-two, bimatrix games of partial conflict DMPS.9-12.6.G

(H) identify the nature and implications of the game called "Prisoners' Dilemma" DMPS.9-12.6.H

(I) explain the game known as "chicken" DMPS.9-12.6.I

(J) identify examples that illustrate the prevalence of Prisoners' Dilemma and chicken in our society DMPS.9-12.6.J

(K) determine when a pair of strategies for two players is in equilibrium DMPS.9-12.6.K

Theory of moves

7. The student analyzes the theory of moves (TOM). The student uses the TOM and game theory to analyze conflicts DMPS.9-12.7

(A) compare and contrast TOM and game theory DMPS.9-12.7.A

(B) explain the rules of TOM DMPS.9-12.7.B

(C) describe what is meant by a cyclic game DMPS.9-12.7.C

(D) use a game tree to analyze a two-person game DMPS.9-12.7.D

(E) determine the effect of approaching Prisoners' Dilemma and chicken from the standpoint of TOM and contrast that to the effect of approaching them from the standpoint of game theory DMPS.9-12.7.E

(F) describe the use of TOM in a larger, more complicated game DMPS.9-12.7.F

(G) model a conflict from literature or from a real-life situation as a two-by-two strict ordinal game and compare the results predicted by game theory and by TOM DMPS.9-12.7.G