**Verona High School**

**Discrete Math**



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| **Unit Title / Topic: Linear Programming** | **Unit Duration: 15 days** | |
| **Stage 1: Desired Results** | | |
| **Students will know that:**   * Math can be used to determine the optimal solution from a range of possible solutions within certain limits or constraints. * Systems of inequalities models a set of relationships between two quantities. * The solution to a linear programming problem is found at the corner points. * Linear programming problems help us find the best way to allocate resources. * The concept of a feasible region enables us to identify solutions to problems. * Real-world situations can be solved using linear programming. | | **Students will be able to:**   * Interpret the verbal model to define the variables and write the objective function. * Represent constraints as inequalities. * Graph systems of inequalities on coordinate axes with labels and scales and determine a feasible region. * Identify important quantities in a practical situation and map their relationships. * Interpret the corner points to find the optimal solution. * Identify and interpret solutions as viable or non-viable options in a real-world context * Graph and solve a system of linear inequalities in two variables. * Create a linear programming model that appropriately represents the situation described. * Solve linear programming problems to optimize certain situations. * Identify important quantities in a practical situation and map their relationships. |

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| **Unit Title / Topic: Graph Theory** | **Unit Duration: 15 days** | |
| **Stage 1: Desired Results** | | |
| **Students will know:**   * The optimal way of traversing a graph. * How to distinguish between the uses of Euler and Hamiltonian circuits. * That coloring graphs and maps with the minimum number of colors can solve many scheduling/conflict situations. * How communication networks that link several locations together are constructed at the least possible cost. | | **Students will be able to:**   * Use graph theory to model relationships in order to solve problems. * Find the optimal way of traversing a graph. * Determine whether a(n) Euler/Hamiltonian circuits/paths exists for any graph. * Create a Traveling Salesperson Problem and find the optimal solution * Represent the Koenigsberg bridge problem and others using a graph. * Determine if a graph is connected or disconnected.. * Use Euler's theorem to determine if a Euler path or circuit exists. * Determine if a path or circuit is a Hamilton path or circuit. * Determine how many different solutions exist for a given graph. * Create a vertex coloring of a graph, and explain its meaning in terms of assigned resources. * Find the chromatic number of a graph. * Interpret a problem of allocation of resources with conflict as a graph, and find an efficient coloring of the graph. |

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| **Unit Title / Topic: Game Theory** | **Unit Duration: 15 days** | |
| **Stage 1: Desired Results** | | |
| **Students will know:**   * How to evaluate and analyze the most important tools and concepts of game theory. * How to critically evaluate different game theoretic models in the appropriate context. * Convert multi-person decision situations into analytic models and analyze them. * Recognize strategic interactions in real life scenarios and analyze them. * That Game theory is used to explain the interdependent behavior of firms in an oligopoly. * That a pay-off matrix is used in game theory to identify the potential outcomes of each decision.. | | **Students will be able to:**   * Explain game theory and interdependent behavior of firms. * Interpret possible outcomes using a payoff matrix. * Recognize and apply dominant strategies in decision-making situations. * Develop winning strategies in a variety of games. * Use backward induction to optimize results. * Use strategies developed in one game in other game situations. * Recognize when mixed strategies are better than fixed strategies. * Work cooperatively in teams to deveop the best strategies. * Recognize the game theory underpinnings in a variety of real-world situations. * Use game theory to analyze situations and select strategies which obtain preferred outcomes for players. |

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| **Unit Title / Topic: Social Network Analysis** | **Unit Duration: 10 days** | |
| **Stage 1: Desired Results** | | |
| **Students will know:**   * Networks are characterized in terms of nodes and the ties, edges, or links that connect them. * Nodes are individual actors, people or things within the network. * Ties, edges or links are the relationships or interactions that connect actors. * Social network analysis is used extensively in a wide range of applications and disciplines. * Social networks affect many important outcomes—health behaviors, labor market opportunities, romantic relationships, and the spread of information and diseases. * Social Network Analysis yields explanations for social phenomena in a wide variety of disciplines from psychology to economics. * We can understand networks and their participants by evaluating the location and grouping of actors in the network. | | **Students will be able to:**   * Prepare data and map these relationships to help you understand how people communicate and exchange information. * Identify the members of the network. * Determine the type of network we are dealing with. * Understand a community by mapping the relationships that connect them as a network, and then trying to draw out key individuals, groups within the network (‘components’), and/or associations between the individuals. * Complete network analysis ‘qualitatively’ – that is, with diagrams drawn by hand. * Know, apply and understand the key descriptors of social networks—size, ccohesivenes, reach, integration and centrality. * Which individuals are linked together in the networkand how they are linked? * Determine if they are Connectors, Mavens or Sales Persons. |

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| **Unit Title / Topic: Bin Packing and Scheduling** | **Unit Duration: 10 days** | |
| **Stage 1: Desired Results** | | |
| **Students will know:**   * How to create a project plan and identify the critical path. * The relationship between bin packing and scheduling problems. * PERT and other critical path methodolgies for problem solving. * Which algorithms are best for certain types of bin packing problems. * In a bin packing problem, objects of different volumes must be packed into the fewest number of bins possible. * There are many variations of this problem, such as 2D packing, linear packing, packing by weight, packing by cost, and so on. They have many applications, such as filling up containers, loading trucks with weight capacity, and creating file backup in removable media. | | **Students will be able to:**   * Determine the critical path from an order-requirement digraph. * Use the list-processing algorithm and order-requirement digraphs to complete a machine scheduling problem. * Use the First-Fit, Next-Fit and Worst-Fit bin-packing algorithms to schedule independent tasks into a minimal number of bins. * Specify in a digraph the order in which tasks are to be performed. * Model projects consisting of several subtasks using a graph. * Create and solve scheduling problems using decreasing time, backflow, and critical path algorithms. * Identify the critical path to determine the earliest completion of time (minimum project time). * Apply critical path scheduling to yield optimal solutions. * Use list-processing algorithm to determine an optimal schedule. * Create and test scheduling algorithms. |

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| **Unit Title / Topic: The Mathematics of Voting & Apportionment** | **Unit Duration: 15 days** | |
| **Stage 1: Desired Results** | | |
| **Students will know:**   * How to rank items, collect votes, and combine rankings. * How to explore plurality and majority winners. * Describe runoff methods. * Examine data for a Condorcet winner and paradox. * Determine Arrow’s conditions. * Explore approval voting. * Determine weighted voting & voting power. * The difference between a winner of a vote by plurality and a winner with majority. * The benefits of using a preference table as opposed to counting each ballot individually. * In any vote involving more than two choices, there is no voting method that will satisfy all of the four fairness criteria. | | **Students will be able to:**   * Interpret and construct a preference schedule for an election involving preference ballots. * Implement the plurality, Borda count, plurality-with-elimination, and pairwise comparisons vote counting methods. * Rank candidates in a preference election. * Identify fairness criteria as they pertain to preferential voting methods. * Understand the significance of Arrows’ impossibility theorem. * Interpret and construct preference schedules for elections involving preference ballots * State the fairness criteria and identify when they are violated. * State Arrows’ impossibility theorem in your own words. * Distinguish between winning with a majority of the votes and winning with a plurality of votes. * Create a preference table by putting together all voters preference ballots. * Determine the winner of a vote using each method. * Explain why each voting method passes or fails the fairness criteria. |