SECONDARY MATHEMATICS I—HONORS STANDARDS

Strand: NUMBER AND QUANTITY: VECTOR AND MATRIX QUANTITIES (N.VM)

Represent and model with vector quantities **(Standards N.VM.1–3).** Perform operations on vectors **(Standards N.VM.4–5).** Perform operations on matrices and use matrices in applications **(Standards N.VM.6–13).**

- **Standard N.VM.1** Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., *v*, |*v*|, ||*v*||, *v*).
- **Standard N.VM.2** Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.
- **Standard N.VM.3** Solve problems involving velocity and other quantities that can be represented by vectors.
- **Standard N.VM.4** Add and subtract vectors.
  - **a.** Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.
  - **b.** Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.
  - **c.** Understand vector subtraction $v - w$ as $v + (-w)$, where $-w$ is the additive inverse of w, with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.
- **Standard N.VM.5** Multiply a vector by a scalar.
  - **a.** Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c(v_x, v_y) = (cv_x, cv_y)$.
  - **b.** Compute the magnitude of a scalar multiple cv using $||cv|| = |c|v$. Compute the direction of cv knowing that when $|c|v \neq 0$, the direction of cv is either along v (for $c > 0$) or against vs (for $c < 0$).
- **Standard N.VM.6** Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.
- **Standard N.VM.7** Multiply matrices by scalars to produce new matrices, e.g., as when all of the pay-offs in a game are doubled.

- **Standard N.VM.8** Add, subtract, and multiply matrices of appropriate dimensions.
- **Standard N.VM.9** Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.
- **Standard N.VM.10** Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.
- **Standard N.VM.11** Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.
- **Standard N.VM.12** Work with 2×2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.
- **Standard N.VM.13** Solve systems of linear equations up to three variables using matrix row reduction.