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Maths - USA

PRECALCULUS

Experience Level: **HIGH SCHOOL**Number of Classes: **VARIABLE**Age Range: **13 - 18 YEARS**

01

Number and Quantity

- The Complex Number System
 - Perform arithmetic operations with complex numbers.
 - Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.
- Represent complex numbers and their operations on the complex plane.
 - Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers)
 - Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane



+91 9953941983



info@omniowl.in

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Number and Quantity (Contd.)

- Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.
- Vector and Matrix Quantities
 - Represent and model with vector quantities.
 - 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., \mathbf{v} , $|\mathbf{v}|$, $\|\mathbf{v}\|$, v).
 - Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.
 - Solve problems involving velocity and other quantities that can be represented by vectors.
- Perform operations on vectors.
 - Add and subtract vectors.
 - Add vectors end-to-end, component-wise, and by the parallelogram rule.
 - Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.
 - Understand vector subtraction $\mathbf{v} - \mathbf{w}$ as $\mathbf{v} + (-\mathbf{w})$, where $-\mathbf{w}$ is the additive inverse of \mathbf{w} , with the same magnitude as \mathbf{w} and pointing in the opposite direction.
 - Multiply a vector by a scalar.
 - Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction



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info@omniowl.in

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Number and Quantity (Contd.)

- Compute the magnitude of a scalar multiple $c\mathbf{v}$ using $\|c\mathbf{v}\| = |c|\|\mathbf{v}\|$. Compute the direction of $c\mathbf{v}$ knowing that when $|c|\mathbf{v}$ is not equal to 0, the direction of $c\mathbf{v}$ is either along \mathbf{v} (for $c > 0$) or against \mathbf{v} (for $c < 0$).
- Perform operations on matrices and use matrices in applications.
 - Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.
 - Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.
 - Add, subtract, and multiply matrices of appropriate dimensions.
 - Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.
 - 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.
 - Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector.
 - Work with 2×2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.



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Algebra

- Reasoning with Equations and Inequalities
 - Solve systems of equations
 - Represent a system of linear equations as a single matrix equation in a vector variable.
 - Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3×3 or greater).

03

Functions

- Interpreting Functions
 - Analyze functions using different representations
 - Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
 - Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.
- Building Functions
 - Build a function that models a relationship between two quantities
 - Write a function that describes a relationship between two quantities.
 - Compose functions.
 - Build new functions from existing functions
 - Find inverse functions.
 - Verify by composition that one function is the inverse of another.
 - Read values of an inverse function from a graph or a table, given that the function has an inverse.
 - Produce an invertible function from a non-invertible function by restricting the domain.



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Functions (Contd.)

- Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.
- Trigonometric Functions
 - Extend the domain of trigonometric functions using the unit circle
 - Use special triangles to determine geometrically the values of sine, cosine, and tangent for $\pi/3$, $\pi/4$, and $\pi/6$, and use the unit circle to express the values of sine, cosine, and tangent for $\pi - x$, $\pi + x$, and $2\pi - x$ in terms of their values for x , where x is any real number.
 - Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.
 - Model periodic phenomena with trigonometric functions
 - Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.
 - Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context.
 - Prove and apply trigonometric identities
 - Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.



+91 9953941983



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Geometry

- Expressing Geometric Properties with Equations
 - Translate between the geometric description and the equation for a conic section
 - Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.
- Geometric Measurement and Dimension
 - Explain volume formulas and use them to solve problems
 - Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.

05

Statistics and Probability

- Using Probability to Make Decisions
 - Calculate expected values and use them to solve problems
 - Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space.
 - Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.
 - Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value.
 - Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value.



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Statistics and Probability (Contd.)

- Use probability to evaluate outcomes of decisions
 - Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.
 - Find the expected payoff for a game of chance.
 - Evaluate and compare strategies on the basis of expected values.



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