

Topics in Mathematics II

MATH153

Spring 2016

This course is provided for students who wish to know what mathematics is all about but who do not wish to be mathematicians. Possible topics are: number systems, mathematical systems, number theory, voting coalitions, geometry, mathematics of finance, topology, linear programming, game theory, and cryptography. A selection of three or more such topics are offered each semester. Prerequisite: D- or higher in MATH 003 Preparation for College Math III or MATH 012 Intermediate Algebra or a score of 72 or higher on mathematics placement testing results; or departmental approval.

COURSE OUTCOMES	OUTCOMES ACTIVITIES
At the end of this course, students will be able to	
Demonstrate an understanding of additive, multiplicative, positional, and ciphered systems of numeration in order to gain an appreciation for numeration systems other than the Hindu-Arabic system.	<ol style="list-style-type: none"> 1. Convert back and forth between an additive system, such as the Egyptian or Roman numeration system, and the Hindu-Arabic system of numeration. (CT, QS, R) 2. Convert back and forth between a multiplicative system, such as the traditional Chinese numeration system, and the Hindu-Arabic system of numeration. (CT, QS, R) 3. Convert back and forth between a positional system, such as the Babylonian or Mayan numeration system, and the Hindu-Arabic system of numeration. (CT, QS, R) 4. Convert back and forth between a ciphered system, such as the classical Greek numeration system, and the Hindu-Arabic system of numeration. (CT, QS, R) 5. Add and subtract in some or all of the numeration systems mentioned above. (CT, QS, R)
Perform conversions within base ten and between base ten and other bases and perform computations in other bases in order to better understand the Hindu-Arabic system of numeration.	<ol style="list-style-type: none"> 1. Convert among standard form, expanded form, and written form. (CT, QS, R, W) 2. Multiply using some or all of the following methods: (CT, QS, R) <ol style="list-style-type: none"> a. Successive duplication, b. Mediation and duplication, c. Lattice method, d. Napier's rods. 3. Convert between base ten and other bases, 4. Add, subtract, multiply, and divide in bases other than ten.
Determine which properties of a mathematical system are satisfied in a given system in order to better understand these properties as they apply to the Hindu-Arabic numeration system	<ol style="list-style-type: none"> 1. Identify the set of elements and the binary operations of a given mathematical system. (R, W, CT, QS) 2. Perform calculations using a binary operation defined by a table. (CT, QS) 3. Determine whether or not the following properties are satisfied in either a given finite or a given infinite mathematical system: (CT, R, W, QS) <ol style="list-style-type: none"> a. Closure property, b. Commutative property, c. Associative property, d. Identity property,

	<p>e. Inverse property, f. Distributive property for a system with two binary operations.</p> <p>4. Determine if a given mathematical system is a group or an abelian group. (CT, QS, R, W)</p>
Perform calculations, solve problems, and analyze properties of modulo systems in order to better understand finite mathematical systems.	<p>1. Determine if two numbers are congruent modulo m. (CT, QS)</p> <p>2. Add, subtract, and multiply modulo m. (CT, QS)</p> <p>3. Solve linear equations in modulo systems. (CT, QS)</p> <p>4. Determine whether or not a given modulo system is an abelian group. (CT, QS)</p> <p>5. Solve applications problems involving modulo systems. (CT, QS, R, W)</p>
Demonstrate an understanding of some of the basic results in number theory in order to gain an appreciation of number and numeracy.	<p>1. Apply the rules of divisibility. (QS, CT, R)</p> <p>2. Find all the divisors of a given number. (CT, QS)</p> <p>3. Determine if a given number is prime or composite. (CT, QS)</p> <p>4. Write the prime factorization of a given composite number. (CT, QS)</p> <p>5. Find the greatest common divisor of two numbers. (CT, QS)</p> <p>6. Find the least common multiple of two numbers. (QS, CT)</p> <p>7. Determine if a number is abundant, deficient, or perfect. (QS, CT)</p> <p>8. Determine if two numbers are friendly numbers. (CT, QS)</p>
Demonstrate an understanding of sequences in order to gain an appreciation of number and numeracy.	<p>1. Determine the next term of a given sequence. (CT, QS, R)</p> <p>2. Determine if a given sequence is arithmetic, geometric, Fibonacci, or neither. (CT, QS, R, W)</p> <p>3. For an arithmetic sequence whose first term and common difference are known, find</p> <ol style="list-style-type: none"> The next several terms, The general term, The sum of the first n terms. (CT, QS, R) <p>4. For a geometric sequence whose first term and common ratio are known, find</p> <ol style="list-style-type: none"> The next several terms, The general term, The sum of the first n terms. (CT, QS, R) <p>5. For a Fibonacci sequence whose first two terms are known,</p> <ol style="list-style-type: none"> Find the next several terms, Find the ratios of successive terms and compare this sequence of ratios with the 'golden ratio.' (CT, QS, R, W)
Demonstrate an understanding of various voting methods and various apportionment methods in order to gain an appreciation of these methods as seen in real-life applications.	<p>1. Solve election problems using the plurality method, the Borda count method, the plurality with elimination method, the pairwise comparison method, the sequential pairwise comparison method, and/or the approval voting method. (CT, QS, R, W)</p> <p>2. Determine if a given voting method violates the majority criterion, the Condorcet criterion, the</p>

	<p>monotonicity criterion, and/or the independence of irrelevant alternatives method. (CT, QS, R, W)</p> <ol style="list-style-type: none"> 3. Explain Arrow's Impossibility Theorem. (CT, W) 4. Solve apportionment problems using the Hamilton method, the Jefferson method, and the Webster method. (CT, QS, TS, R, W) 5. Explain the quota rule, the Alabama paradox, the population paradox, and the new states paradox. (CT, W) 6. Verify that a specified paradox occurs for a given apportionment scenario. (CT, QS, TS, R, W) 7. Explain the Balinski and Young Impossibility Theorem. (CT, W)
<p>Demonstrate an understanding of basic definitions and properties of Euclidean geometry and measurement formulas in order to solve related problems.</p>	<ol style="list-style-type: none"> 1. Correctly identify lines, rays, half-lines, and line segments. (CT, QS, R) 2. Correctly identify acute angles, right angles, obtuse angles, and straight angles. (CT, QS, R) 3. Correctly identify triangles as obtuse, right, or obtuse, and as scalene, isosceles, or equilateral. (CT, QS, R) 4. Correctly identify a given quadrilateral as a trapezoid, parallelogram, rhombus, rectangle, or square. (CT, QS, R) 5. Correctly identify a polygon by the number of its sides. (CT, QS) 6. Solve problems involving vertical angles, complementary angles, and supplementary angles. (CT, QS, R) 7. Solve problems involving parallel lines cut by a transversal. (CT, QS, R) 8. Solve problems involving the sum of the angles in a polygon. (CT, QS, R) 9. Solve problems involving similar triangles and congruent triangles. (CT, QS, R) 10. Solve problems involving right triangles and the Pythagorean Theorem. (CT, QS, R) 11. Use measurement formulas to find <ol style="list-style-type: none"> a. Perimeter of polygons, b. Area of triangles and quadrilaterals, c. Circumference and area of circles, d. Volume of rectangular solids, pyramids, cylinders, cones, and spheres, e. Surface area of three-dimensional objects. (CT, QS, R)
<p>Use simple and compound interest formulas in order to solve applications problems involving interest rates.</p>	<ol style="list-style-type: none"> 1. Calculate simple interest and maturity value. (CT, QS, TS, R) 2. Calculate compound interest and maturity value. (CT, QS, TS, R) 3. Calculate present value. (CT, QS, TS, R) 4. Understand and compute effective annual yield. (QS, CT, TS, R) 5. Find the value of an annuity. (QS, CT, TS, R)
<p>Use formulas involved in installment buying in order to make informed decisions in real-life situations involving buying on credit.</p>	<ol style="list-style-type: none"> 1. Determine the amount financed, the installment price, and the finance charge for a fixed loan. (CT, QS, TS, R, W) 2. Determine the APR. (CT, QS, TS, R, W)

	<ol style="list-style-type: none"> 3. Compute unearned interest and the payoff amount for a loan paid off early. (CT, QS, TS, R, W) 4. Find the interest, the balance due, and the minimum monthly payment for credit card loans. (CT, QS, TS, R, W) 5. Calculate interest on credit cards using the unpaid balance method, the previous balance method and/or the average daily balance method. (QS, CT, TS, R, W)
<p>Examine the cost of home ownership in order to make decisions as an educated consumer.</p>	<ol style="list-style-type: none"> 1. Compare and contrast fixed-rate mortgages and variable-rate mortgages. (CT, R, W) 2. Given information on income and monthly payments due, determine the maximum mortgage amount a given home buyer is qualified to borrow. (CT, QS, TS, R) 3. Compute interest costs for a fixed-rate mortgage. (CT, QS, R) 4. Compute the down payment. (CT, QS, TS, R) 5. Prepare a partial loan amortization schedule for a fixed-rate mortgage. (CT, QS, TS, R, W) 6. Compute closing costs. (CT, QS, TS, R)
<p>OPTIONAL: Demonstrate an understanding of investing in stocks, bonds, and mutual funds in order to make decisions as an educated consumer.</p>	<ol style="list-style-type: none"> 1. Compare and contrast stocks, bonds, and mutual funds as investments. (CT, R, W) 2. Get information from stock tables. (CT, R) 3. Calculate the basic cost for a given number of shares of a specific stock using stock tables. (CT, QS, R) 4. Calculate broker fees. (CT, QS, R) 5. For a given investment scenario, find the total purchase price, the total dividend amount, the capital gain or loss, the total return, and the percentage return. (CT, QS, TS, R, W) 6. Find the total return earned by a given bond investment. (CT, QS, TS, R) 7. Find the effective rate of return for a given mutual fund scenario. (CT, QS, TS, R)
<p>Demonstrate an understanding of the basic definitions and properties of network theory, topology, hyperbolic geometry, elliptic geometry, and fractals in order to develop an appreciation for the nature of non-Euclidean geometry.</p>	<ol style="list-style-type: none"> 1. In a given network determine which vertices are even and which are odd. (CT, QS) 2. Determine if a given network is traversable or not. (CT, QS) 3. Find a path that traces a traversable network. (CT, QS, W) 4. Solve related network problems. (CT, QS, R, W) 5. Identify the genus of an object. (CT, QS) 6. Determine if two objects are topologically equivalent. (CT, QS) 7. For hyperbolic and elliptic geometry <ol style="list-style-type: none"> a. Identify at least one mathematician responsible for its development. (W) b. Identify the surface required for this type of geometry. (CT, W) c. Explain how Euclid's parallel postulate is changed. (CT, W) d. Explain why the sum of the measures of the angles in a triangle is not 180°. (CT, W) 8. Describe what a fractal is. (CT, W)

	9. Use iteration techniques to demonstrate the construction of a fractal. (CT, QS, R, W)
Use linear programming methods in order to solve maximum and minimum problems.	<ol style="list-style-type: none"> 1. Solve a linear programming problem by <ol style="list-style-type: none"> a. Writing the appropriate inequalities subject to the given restrictions or constraints and the objective equation. (CT, QS, R) b. Graphing the inequalities to find the region of feasible solutions. (CT, QS, TS) c. Determine the corner points of the feasible region. (CT, QS) d. Use the objective equation to determine which of these points gives a maximum or minimum value. (CT, QS, TS) 2. Solve related applications problems. (CT, QS, TS, R, W)
Demonstrate an understanding of the basic definitions and rules of game theory in order to gain an appreciation of the applications of game theory in business, economics, and the sciences.	<ol style="list-style-type: none"> 1. Construct the game matrix for a given two-person game. (CT, R, W) 2. Determine whether or not a game matrix represents a strictly determined game. (CT, QS) 3. Given the matrix for a strictly determined game, identify the saddle point, find the optimal pure strategy for each player, and the value of the game. (CT, QS, R, W) 4. Given the matrix for a game that is not strictly determined, find the optimal mixed strategy and the value of the game for the row player. (CT, QS, R, W) 5. Solve related application problems. (R, QS, CT, W)
Strengthen Core Competencies** in order to increase success in this and other courses and in the workplace.	Referenced above

**Indicate the Core Competencies that apply to the outcomes activities and assessment tools: Critical Thinking (CT); Technology Skills (TS); Oral Communications (OC); Quantitative Skills (QS); Reading (R); Writing (W).