Course Title: Precalculus Mathematics  
SCNS Number: MAC 2140  
Prepared by: Joseph Hoffmann  
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COURSE DESCRIPTION:  
MAC 2140 Precalculus Mathematics (3) FA, SP, SU. Prerequisite: C or better in MAC 1105 or MAC 1104. This course is one of the prerequisites for MAC2311. Techniques in graphing, properties of polynomial and rational functions, applications of exponential and logarithmic functions, solutions of higher degree polynomial equations, solutions of systems of linear equations using matrices and determinants, sequences and series, proof by mathematical induction, elementary mathematical logic, the binomial theorem and an introduction to conic sections. A graphing calculator is required - see instructor for the most appropriate one. Lecture 3 hours.

COURSE GOALS:  
The main goal of this course is to help prepare students for calculus. The course can be used to satisfy part of the General Education mathematics requirement, or it can serve as an elective.

PERFORMANCE OBJECTIVES:  
By the end of the course the student should be able to do the following:

Polynomials:

1. Know the definition of polynomial functions and the characteristics of their graphs, with emphasis on local behavior (recognizing local extrema on a graph and using a graphing calculator to approximate the coordinates of such points at least to the nearest thousandth) and end behavior (knowing how the evenness or oddness of the degree of a polynomial and the sign of its leading coefficient determine the shape of the graph as x approaches positive infinity or negative infinity).
2. Use a graphing calculator to approximate, at least to the nearest thousandth, the x-intercepts of the graph of a polynomial function.
3. Divide one polynomial \( P(x) \) by another polynomial \( D(x) \) using long division to find the quotient \( Q(x) \) and the Remainder \( R(x) \), and correctly write the result in the form \( P(x) = Q(x)D(x) + R(x) \).

4. Use, and interpret the results of, synthetic division when dividing a polynomial by \( x - c \), where \( c \) is a real number.

5. State and use the Remainder Theorem and the Factor Theorem.

6. Identify multiplicity of roots in factored polynomials.

7. List all possible rational zeros of a polynomial with integer coefficients.

8. Use Descartes’ Rule of Signs to determine the possible number of positive real zeros and negative real zeros of a polynomial with real coefficients. (Optional)

9. Find the smallest positive integer upper bound and the largest negative integer lower bound for the real zeros of a polynomial, using synthetic division.

10. Perform arithmetic operations on complex numbers.

11. Graph a complex number and find its modulus and its conjugate. (Graphing Optional)

12. State the Fundamental Theorem of Algebra.

13. Explain why the Conjugate Roots Theorem guarantees that a polynomial of odd degree and real coefficients has at least one real zero.

14. Given several zeros, construct a polynomial having those zeros.

15. Find all the exact roots of selected polynomial equations by using a combination of the theorems and techniques presented in this chapter.

16. Define a rational function and use algebraic methods to find its x- and y-intercepts and any vertical, horizontal, and slant asymptotes of its graph.

17. Sketch the graph of a rational function either by algebraic analysis or by using a graphing calculator.

**Exponential and Logarithmic Functions:**

18. Identify the properties, domain, and range of exponential functions and sketch their graphs.

19. Identify the natural exponential function and its connection with compound interest. (Compound Interest Optional)

20. Solve applied problems involving population growth, radioactive decay, and compound interest. (Compound Interest Optional)

21. Recognize logarithmic functions as inverses of exponential functions.

22. Find the domain and the range of a logarithmic function and draw its graph.

23. Know the properties of logarithms and use them correctly.

24. Solve exponential and logarithmic equations without calculators (when possible) and with calculators (when necessary).

25. Know and use the change-of-base formula for logarithms.

26. Using algebraic methods, solve exponential and logarithmic equations relating to applied problems such as radiocarbon dating, Newton’s Law of Cooling, pH determinations and Richter scale problems, and approximate exact solutions by using a calculator.
**Introduction to Linear Algebra:**

27. Solve systems of linear and nonlinear equations by the substitution and elimination methods and by the use of a graphing calculator.
28. Multiply compatible matrices without and with a graphing calculator.
29. Define the inverse of a square matrix and find it by using a graphing calculator;
30. Use a graphing calculator to solve a linear system of three equations in three unknowns by multiplying the inverse of the coefficient matrix and the matrix of constant terms.
31. Compute the determinants of 2x2 and 3x3 matrices without and with a graphing calculator.
32. Know and use Cramer’s Rule to solve 2x2 and 3x3 systems of linear equations.
33. By algebraic methods, find the partial fraction decomposition of a rational function, whether the denominator is a product of distinct or repeated linear or irreducible quadratic factors.

**Conic Sections:**

34. State the locus definitions of a parabola, an ellipse, and a hyperbola, and derive equations for these conic sections when the axes of symmetry are horizontal or vertical.
35. Given the equation of a parabola, find its vertex, its focus, its directrix, and its axis of symmetry, and sketch the graph.
36. Find the equation of a parabola, given a minimum amount of information about its vertex, focus, directrix, focal width, and axis of symmetry.
37. Given the equation of an ellipse, find its center, foci, major and minor axes, intercepts, and eccentricity, and sketch the graph; conversely, given minimal information about these features of the graph of an ellipse, find the equation.
38. Given the equation of a hyperbola, find the asymptotes and intercepts of the graph and draw the graph.
39. Recognize and sketch the graphs of conic sections whose centers have been shifted horizontally or vertically.

**Sequences and Series:**

40. Know the notation and terminology associated with sequences and series.
41. List the terms of a sequence defined either explicitly or recursively.
42. Expand a sum given in sigma notation.
43. Write the nth term of a sequence, given the first several terms of the sequence.
44. Identify arithmetic sequences, find the formula for the nth term, and find the sum of the first n terms.
45. Identify geometric sequences, find the formula for the nth term, find the sum of the first n terms, and find the sum of an infinite geometric sequence having a common ratio whose absolute value is less than 1.

46. Calculate expressions involving factorial notation.

47. Write the first eight rows of Pascal’s Triangle, and use either it or the Binomial Theorem to expand powers of binomials.

48. Using the Binomial Theorem to find the r-th term of the expansion of a binomial.

49. Using the Principle of Mathematical Induction to prove basic summation formulas.

**Logic (Optional):**

50. Know the truth-tables for the five basic logical operators: negation, conjunction, disjunction, material implication (conditional statement), and material equivalence (biconditional statement).

51. Know the logical relationship (equivalence or non-equivalence) between a given conditional statement and its converse and its contrapositive.