**HIBBING COMMUNITY COLLEGE**
**COURSE OUTLINE**

**COURSE NUMBER & TITLE:** MATH 2211 - Differential Equations with Introductory Linear Algebra
**CREDITS:** 5 (5 Lec / 0 Lab )
**PREREQUISITES:** "C" or better in MATH 2111: Calculus 2 or Equivalent

**CATALOG DESCRIPTION:**
Differential Equations with Introductory Linear Algebra focuses on first and second-order differential equations, higher order differential equations, Laplace transforms, vectors, matrix algebra, eigenvectors and eigenvalues, systems of differential equations, numerical methods, series solutions, and mathematical models. MNTC goal area: (4)Math & Logical Reasoning.

**OUTLINE OF MAJOR CONTENT AREAS:**
I. First-order differential equations
II. Models and numerical methods involving first-order equations
III. Linear systems and matrices
IV. Vector spaces
V. Higher order differential equations
VI. Eigenvalues and eigenvectors
VII. Linear systems of differential equations
VIII. Laplace transform methods
IX. Power series method

**COURSE GOALS/OBJECTIVES/OUTCOMES:**
Students will
1. verify by substitution that a function is a solution to a given differential equation.
2. solve initial value problems involving 1st order differential equations.
3. determine by inspection at least one solution to a differential equation.
4. find the position function of a moving particle with a given acceleration, initial position, and initial velocity.
5. solve problems involving vertical motion with gravitational acceleration using differential equations.
6. construct a slope field for a differential equation and use it to sketch an approximate solution curve.
7. use a solution curve to estimate the desired value of a solution to a differential equation.

8. determine if a differential equation has a unique solution.
9. solve 1st order differential equations that are separable.
10. identify singular solutions for an ordinary differential equation.
11. utilize 1st order differential equations to analyze mathematical models.
12. solve 1st order linear differential equations.
13. solve 1st order homogeneous differential equations.
14. solve 1st order differential equations that are exact.
15. find a general solution to a reducible 2nd order differential equation.
16. analyze population models using differential equations.
17. utilize differential equations to analyze acceleration-velocity models.
18. use Euler's method to approximate a solution to a given differential equation.
19. use improved Euler's method to approximate a solution to a given differential equation.
20. use the Runge-Kutta method to approximate the solution of a 1st order differential equation.
21. determine whether a system of equations is consistent or inconsistent.
22. determine if a system has one, infinitely many, or no solutions.
23. find the unique solution to a consistent system of equations.
24. describe the infinite solution set of a consistent system in terms of an arbitrary parameter.
25. use elimination to transform an augmented coefficient matrix to echelon form.
26. use elimination to transform an augmented coefficient matrix to reduced echelon form.
27. manipulate matrices using addition, multiplication, and scalar multiplication.
28. write a homogeneous system in matrix form and find its solution in vector form.
29. use the inverse of a matrix to solve a homogeneous system of equations.
30. evaluate a determinant using cofactor expansion.
31. apply Cramer's rule to solve a system of equations.
32. prove elementary properties of matrix operations.
33. use vector addition and scalar multiplication to manipulate vectors.
34. determine whether two vectors are linearly dependent or independent.
35. express a vector as a linear combination of other vectors.
36. determine if a set is a subspace of another set.
37. find solution vectors such that the solution space is the set of all linear combinations of the solution vectors.
38. determine if a set of vectors form a basis.
39. find a basis for a subspace.
40. determine a basis for the row space and column space of a matrix.
41. determine whether a set of vectors is mutually orthogonal.
42. find a basis for the orthogonal complement of a set of vectors.

43. find a particular solution to a homogeneous 2nd order linear differential equation.
44. determine whether pairs of functions are linearly dependent or independent.
45. find general solutions of differential equations with distinct real roots and repeated real roots.
46. use the Wronskian to prove that functions are linearly independent.
47. solve homogeneous 2nd order differential equations when the auxiliary equation has complex roots.
48. utilize 2nd order differential equations in the development and analysis of mathematical models.
49. identify characteristics of a system that is under damped, critically damped, and over damped.
50. use the method of undetermined coefficients to solve non-homogeneous 2nd order differential equations.
51. solve non-homogeneous 2nd order differential equations by using the variations of parameters method.
52. find the eigenvalues and associated eigenvectors of a matrix.
53. find a basis for an eigenspace.
54. transform a differential equation or system of differential equations into an equivalent system of 1st order differential equations.
55. find a general solution for a 1st order system of differential equations.
56. use matrix methods to solve a system of differential equations.
57. use the eigenvalue method to solve a linear system of differential equations.
58. utilize 2nd order systems of differential equations to analyze models such as mass and spring system models or electrical circuit models.
59. solve higher order linear differential equations.
60. find the Laplace transform of a function.
61. find the inverse Laplace transform of a function.
62. use Laplace transforms to solve initial value problems.
63. apply the translation theorem to find the Laplace transform of a function and the inverse Laplace transform.
64. use partial fractions to find the inverse Laplace transform of a function.
65. find the convolution of functions.
66. use convolutions to find inverse Laplace transforms.
67. apply integration and differentiation techniques to find the Laplace transform of a function.
68. find Laplace transforms of the unit step function, periodic function, and gamma function.
69. use Laplace transforms to solve differential equations.
70. find a power series solution of a differential equation.
71. determine the radius of convergence of a power series and the recurrence relation.

72. use infinite series to solve differential equations about regular analytic points.

**MNTC GOALS AND COMPETENCIES MET:**
Mathematical/Logical Reasoning

**HCC COMPETENCIES MET:**
Communicating Clearly and Effectively
Thinking Creatively and Critically

**STUDENT CONTRIBUTIONS:**
The student will attend class regularly, participate in class discussion, complete daily assignments, in-class exercises, exams, and a comprehensive final examination. The student will spend a minimum of two hours completing assignments for every hour in class. These must be accomplished in such a way that they meet minimum standards set by the instructor.

**STUDENT ASSESSMENT SHALL TAKE PLACE USING INSTRUMENTS SELECTED/DEVELOPED BY THE COURSE INSTRUCTOR.**

**SPECIAL INFORMATION: (SPECIAL FEES, DIRECTIVES ON HAZARDOUS MATERIALS, ETC):**
The student may be required to provide a calculator for this course. If a specific calculator model is required, this model will be specified by the instructor on the course syllabus. Examples of calculators which may be required include but are not limited to the following: the TI89 and the TI Voyage 200.

**AASC APPROVAL DATE: January 18, 2012**

**REVIEW DATE: January 2017**

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