COMMON COURSE OUTLINE: Course discipline/number/title: MATH 2238: Differential Equations and Linear Algebra

A. CATALOG DESCRIPTION
1. Credits: 5
2. Hours/Week: 5
3. Prerequisites (Course discipline/number): MATH 1128 and College Level Reading
4. Co-requisites (Course discipline/number): None
5. MnTC Goals (if any): NA

This course is an in-depth look at topics such as mathematical models, first-order differential equations, applications of linear and nonlinear equations, and other topics.

B. DATE LAST REVISED (Month, year): February, 2014

C. OUTLINE OF MAJOR CONTENT AREAS:
1. Differential Equations
   a) First Order Ordinary Differential Equations: Separable, Linear, and Exact
   b) Higher Order Linear Ordinary Differential Equations
   c) Systems of Linear ODE
   d) Systems of Non-Linear ODE
   e) Limit Cycles, Chaos, and Qualitative Analysis
   f) Laplace Transforms
   g) Power Series Methods
   h) (Optional)Introduction to the Three Types of Partial Differential Equations.
2. Linear Algebra
   a) Matrix Representations of Systems and their Solution Methods
   b) Vector Spaces, Subspaces, Spanning Sets, Linear Independence, and Bases.
   c) Determinants and Cramer’s Rule
   d) Linear Transformations, Matrix Representations, and Properties
   e) Eigenvalues and Eigenvectors
   f) Equivalency, Similarity, Diagonalization, Factorizations
   g) (optional) Least Squares Approximations
   h) (optional) Gram-Schmidt Orthogonalization Process and Applications to Fourier Analysis
3. Technology
   a) Optional: Introduction to MatLab, Maple, Mathematica, or TI-Basic.
   b) Optional: Solutions to ODE’s via technology
   c) Optional: Matrix Equation solutions via Numerical Analysis
   d) Optional: Eigenvalue and Eigenvector Estimation Techniques

D. LEARNING OUTCOMES (GENERAL): The student will be able to:
1. Solve first order separable equations by separation of variables and integration.
2. Solve first order Linear Equations by variation of parameters and/or integrating factors.
3. Calculate solutions to higher order linear ODE’s by suing characteristic polynomials, annihilator methods, variation of parameters, and modeling as a system of differential equations.
4. Calculate solutions to systems of linear ODE’s by using Eigenvalues and Eigenvectors.
5. Qualitatively analyze non-linear ODE by using linear algebra to study the graphs generated by the systems.
6. Compute both Laplace Transforms and Inverse Laplace Transforms in order to solve ODE’s.
8. Optional: Recognize and understand the significance of the 3 types of PDE’s in the natural sciences.
9. Translate systems of equations into matrix equations and vice versa.
10. Solve Matrix Equations by Row-Reductions, Inverses, or Cramer’s Rule;
11. Understand the definitions of Vectors Spaces and prove a space in question satisfies and appropriate axioms.
12. Create subspaces from known vector spaces and prove their subspace is a vector space.
13. Calculate Determinants by expansion by cofactors and by row reduction and elementary matrices.
14. Understand the axioms of Linear Transformation and uses them to prove a mapping meets the requirements.
15. Calculate Eigenvalues and Eigenvectors for any square matrix.
D. LEARNING OUTCOMES (GENERAL): The student will be able to: Continued...

16. Show matrices are row equivalent, column equivalent or similar by analyzing row spaces, and Eigenvectors and Eigenvalues.
17. Perform matrix factorizations such as the LU Decomposition.
18. Optional: Prove the best approximation theorem and use it to set up least squares problems.
19. Optional: Implement the Gram-Schmidt Orthogonalization algorithm in order to produce orthonormal bases.
20. Optional: Apply Gram-Schmidt to compute the Fourier Coefficients and Calculate Fourier Series for common elementary functions.
21. Optional: Solve ODE problems by understanding the basic commands and syntax use in one of the popular Mathematics Software programs such as MatLab, Mathematica, Maple, or TI Graphing Calculators.
22. Optional: Estimate Solutions to Matrix problems such as systems, Eigenvalue/vector Estimates, or Orthogonalization.

E. LEARNING OUTCOMES (MNTC): NA

F. METHODS FOR EVALUATION OF STUDENT LEARNING:
1. Homework
2. Quizzes
3. Group Projects
4. Exams
5. Comprehensive Final Exam

G. RCTC CORE OUTCOME(S) ADDRESSED:
- Communication
- Critical Thinking
- Global Awareness/Diversity
- Civic Responsibility
- Personal/Professional Accountability
- Aesthetic Response

H. SPECIAL INFORMATION (if any):
A Texas Instruments Graphing Calculator is required.