PELLISSIPPI STATE TECHNICAL COMMUNITY COLLEGE
MASTER SYLLABUS

# CALCULUS IV
# MTH 2420

**Class Hours: 5.0** **Credit Hours: 5.0**

**Laboratory Hours: 0.0** **Date Revised: Fall 1999**

**Catalog Course Description:**

This course of differential equations merged with matrix math concepts gives meaning to the first and utility to the second. Topics include first-order differential equations; mathematical models and numerical methods; linear equations of higher order; linear systems of differential equations; solutions using matrix calculations, eigenvalues, and eigenvectors; nonlinear systems and phenomena; Laplace transforms; and series solutions.

**Entry Level Standards:**

A thorough knowledge of algebraic, trigonometric, and beginning through multivariable calculus functions is necessary for entrance to this course.

**Prerequisite:**

MTH 2410

**Textbook(s) and Other Reference Materials Basic to the Course:**

Required:
Zill, Dennnis G. *Differential Equations with Computer Lab Experiments*. 2nd ed. Brooks/Cole Pub. Co., 1998.
A graphing calculator.
References:
Nagle, R. Kent and Edward B. Staff. *Fundamentals of Differential Equations*. 4th ed. Addison-Wesley Pub. Co., 1996.
Farlow, Stanley J. *Differential Equations and Their Applications*. McGraw-Hill, Inc., 1994.
Edwards, C. H. and David E. Penney. *Differential Equations-Computing and Modeling.* Prentice-Hall, 1996.
Rice, Bernard J. and Jerry D. Strange. *Ordinary Differential Equations with Applications*. 3rd ed. Brooks/Cole Pub. Co., 1994.

**I. Week/Unit/Topic Basis:**

| **Week** | **Topic** |
|---|---|
| 1 | Definitions and Terminology, Initial-value Problems; 1.1-1.2 |
| 2 | Direction Fields, Phase Portraits and Stability, Separable Equations; 2.1-2.2 |
| 3 | Linear Equations, Mathematical Models; 2.3-2.4 |

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|---|---|
| 4 | Numerical Methods; Eulers Method, Runge-Kutta Method; 2.5 |
| 5 | General Solutions of Linear Equations, Homogeneous Equations with Constant Coefficients, Phase Portraits and Stability; 3.1-3.3 |
| 6 | Nonhomogeneous Equations, the Method of Undetermined Coefficients and Variation of Parameters, Cauchy-Euler Equations; 3.4-3.5 |
| 7 | Mathematical Models; Initial-Value and Boundary-Value Problems; 3.6-3.7 |
| 8 | Systems of Differential Equations-Elimination Method, Numerical Solutions, Nonlinear Equations; 3.8-3.10 |
| 9 | Matrix Algebra (including Transposition, Row Operations, etc.), Matrix Solutions to Linear Systems; Appendix I |
| 10 | Determinants, Cofactors, and Inverses; The Eigenvalue Method for Linear Systems; Appendix I |
| 11 | Homogeneous Linear Systems with Constant Coefficients; 4.1-4.2 |
| 12 | Nonhomogeneous Linear Systems, Mathematical Models, Phase Portraits and Stability; 4.3-4.5 |
| 13 | Laplace Transforms and Inverse Transforms, Translation Theorems; 5.1-5.2; Transformation of Initial Value Problems, Translation, Periodic Functions; 5.3-5.5 |
| 14 | Taylor Series Solutions: supplementary material |
| 15 | Power Series Solutions: About Ordinary Points, About Singular Points, Bessels Equation (time permitting); 6.1-6.3 |
| 16 | Final Exam |

**II. Course Objectives*:**

A. Gain a working knowledge of first and second-order differential equations and their solutions. I, III, IV

B. Apply the concepts of differential equations to suitable mathematical models. II, III, IV, V

C. Demonstrate familiarity with systems of differential equations, their solutions and their applications. II, III, IV, V

D. Scrutinize solution techniques comparatively (graphical, numerical, matrix, symbolic, transforms, etc.) I, IV, V

*Roman numerals after course objectives reference goals of the Mathematics department.

**III. Instructional Processes*:**

Students will:

1. Employ graphing calculators and/or computer software as tools for the field of study. *Technological Literacy Outcome*

2. Advance their skills in analysis, synthesis, symbol manipulation, graphical

conceptualization and technical writing skills using the work and/or projects assigned. *Problem Solving and Decision Making Outcome, Numerical Literacy Outcome, Communication Outcome*

3. Analyze real life problems such as: using first order differential equations to construct compartmental analysis, to investigate growth and decay models as well as heating and cooling models, and to analyze population growth. In addition, second order differential equations would be used to explain mechanical vibrations, spring/pendulum, harmonic motion and forced oscillation models. *Problem Solving and Decision Making Outcome, Numerical Literacy Outcome, Transitional Strategy*

4. Actively engage in student-led discussions and brainstorming sessions about mathematical/physics based models inherent to the course. *Active Learning Strategy, Transitional Strategy*

5. Investigate and justify the engineering concepts contained in fields of dynamics and circuit analysis. *Problem Solving and Decision Making Outcome, Numerical Literacy Outcome, Transitional Strategy*

*Strategies and outcomes listed after instructional processes reference Pellissippi State□s goals for strengthening general education knowledge and skills, connecting coursework to experiences beyond the classroom, and encouraging students to take active and responsible roles in the educational process.

**IV. Expectations for Student Performance*:**

Upon successful completion of this course, the student should be able to:

1. Solve □separable□, □exact□, □integrating factor□ and □Bernoulli□ first order differential equations symbolically. A

2. Apply first order differential equations solution techniques to mathematical models (including: population, growth and decay, heating/cooling, compartmental analysis, Newtonian mechanics, terminal velocity, and logistic models). B

3. Define the numerical solutions (Euler□s and Runge-Kutta) to first order differential equation. A

4. Illustrate familiarity with graphical solutions to first order differential equations using direction fields, phase portraits and stability. A

5. Determine the best method (graphically, numerically, or symbolically) of solving first order differential equations. A

6. Calculate general and particular solutions to second order linear homogeneous and nonhomogeneous equations with constant coefficients (using □auxiliary equations□, □undetermined coefficients□, and □variation of parameters□ techniques). A

7. Apply second order differential equation solution techniques to mathematical models (including compartmental, mechanical vibration, spring and pendulum models) B

8. Analyze the behavior of the second order solutions for ordinary differential equations. A

9. Find solutions to systems of differential equations numerically and by elimination. C

10. Employ matrix algebra concepts to solve linear systems (including row operated solutions, inverses, determinants, transposition and Eigenvalue solutions) C

11. Solve homogeneous systems of differential equations using Eigenvalues. C

12. Use Laplace transforms and translation theorems to find differential equation solutions. A

13. Determine series solutions (Taylor and power series) to differential equations. A

14. Analyze the behavior of the solutions for ordinary differential equations. A

15. Scrutinize solution techniques comparatively (graphical, numerical, matrix, symbolic, transforms, etc.,) to gain insight into choosing the best method for the problem at hand. D

*Letters after performance expectations reference the course objectives listed above.

**V. Evaluation:**

A. Testing Procedures:

Students are evaluated primarily on the basis of tests, computer applications or projects, quizzes, and homework. A minimum of four major tests is recommended.

B. Laboratory Expectations:

As assigned by instructor. Computer laboratory work will be an integral part of this course, but not a separate entity.

C. Field Work:

As assigned by instructor

D. Other Evaluation Methods:

As assigned by instructor

E. Grading Scale:

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|---|---|
| 93% - 100% | A |
| 88 - 92 | B+ |
| 83 – 87 | B |
| 78 – 82 | C+ |
| 70 – 77 | C |
| 60 – 69 | D |
| Below 60 | F |

**VI. Policies:**

A. Attendance Policy:

Pellissippi State Technical Community College expects students to attend all scheduled instructional activities. As a minimum, students in all courses must be present for a least 75 percent of their scheduled class and laboratory meetings in order to receive credit for the course. Individual departments/programs/disciplines, with the approval of the vice president of Academic and Student affairs, may have requirements that are more stringent.

B. Academic Dishonesty:

Individual instructors must distribute their policy on academic dishonesty during the first week of class.