Coffeyville Community College

#MATH 202

COURSE SYLLABUS

FOR

DIFFERENTIAL EQUATIONS

Ryan Willis
Instructor

COURSE NUMBER: MATH 202 **COURSE TITLE:** Differential Equations

CREDIT HOURS: 3

INSTRUCTOR: Ryan Willis

OFFICE LOCATION: Math/Science Offices, Second Floors Arts and Sciences Building

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OFFICE HOURS: See schedule posted on door

PREREQUISITE(S): Calculus with Analytic Geometry III

REQUIRED TEXT AND MATERIALS: *Elementary Differential Equations and Boundary Value Problems* by Boyce/DiPrima

COURSE DESCRIPTION: The course treats the various types of solutions of differential equations.

EXPECTED LEARNER OUTCOMES: Upon completion of this course, the student will be able to:

1. Solve first order, first degree differential equations.
2. Solve linear differential equations.
3. Utilize LaPlace Transform to solve differential equations.
4. Solve differential equations by numerical methods.
5. Utilize power series to solve differential equations.
6. Solve systems of differential equations.
7. Solve given application problems that involve differential equations.

LEARNING TASKS & ACTIVITIES: The class will meet during the scheduled class time for recitation and discussion of selected chapters from the text. A traditional lecture approach will be used. Homework regarding the discussed material will be assigned at the end of each class period. Periodic quizzes will also be given to assess comprehension. Note the Course Outline for a detailed breakdown of scheduled self evaluations.

COURSE OUTLINE:

Weeks	Chapter
1-3	1 & 2—First Order, First Degree Equations
	Exam #1
3-6	3 & 4—Linear Equations with Constant Coefficients
	Exam #2
7-10	6-LaPlace Transforms
	Exam #3
10-13	7—Systems of Equations
	Exam #4
13-16	5—Power Series Solutions
	Final Exam

ASSESSMENT OF OUTCOMES:

Grades of A (90-100), B (80-89), C (70-79), D (60-69), and F (0-59) are given in this course. An incomplete is given if previously agreed upon by the instructor with a specific time designated for the completion of the incomplete work. Please note the college's policy on incompletes as stated in the college catalog.

Tests MUST be taken on the scheduled day and during the regular class period. ONLY if arrangements are made with the instructor PRIOR to the original test date will a student be allowed to take a test late (makeup test). The makeup test will be taken at a time that the instructor and the student agree upon. A maximum of one makeup test will be allowed, and must be completed before the last week of class.

A student's final course will be based upon (a) Four chapter tests worth 100 points each, with the lowest test score being dropped, (b) Daily activity score worth 100 points, consisting of quizzes, homework, and attendance, and (c) Final Exam worth 100 points.

ATTENDANCE:

Attendance in a math course is essential for any degree of success in that course. When it is determined that lack of attendance is jeopardizing the success of the student, counseling will be in order to conclude whether the student should remain enrolled in the class. The student should not miss class periods for a course of this type. In each class period new ideas are presented which build upon the ideas of the previous class period. These ideas, in turn, lay the foundation for what will be discussed at the next class period. When a student is absent all information should be obtained from a fellow student concerning the assignment covered or to be covered. Absence is no excuse for being unaware of the progress and activities of the class.

COMPETENCIES:

UNIT I: FIRST ORDER, FIRST DEGREE EQUATIONS

THE STUDENT WILL SOLVE FIRST ORDER, FIRST DEGREE DIFFERENTIAL EQUATIONS

1. Define differential equation.
2. Define a) Order b) Degree
3. Write the general form of a first order, first degree differential equation.
4. Write the general form of a separation of variables type diff. eq.
5. Solve given problems using the separation of variables methods.
6. Define homogeneous function.
7. Define homogeneous differential equation.
8. State and prove: If Mdx + Ndy = 0 is a homogeneous differential equation and v = y/x then the equation reduces to $\frac{dx}{x} + \frac{N(1,v)dv}{N(1,v)v + M(1,v)} = 0$
9. Solve given homogeneous differential equations.
10. Define exact differential equation.
11. Define total differential.
12. State and prove: Mdx + Ndy = 0 is $\frac{\partial M}{\partial y} = \frac{\partial N}{\partial x}$
13. Determine whether a given differential equation is exact.
14. Solve given exact differential equations.
15. State and prove: If $\exists v \ni vdy + vpydx = v$ Qdx is exact then $v = \exp(\int pdx)$.
16. State and prove: The solution of $dy + p(x)dx = Q(x)dx$ is $vy = \int vQdx$ where $v = \exp(\int pdx)$.
17. Solve equations of the form dy + p(x)dx = Q(x)dx.
18. Solve given differential equations by finding the integrating factor by inspection.
19. State and prove: If $y' + p(x)y = Q(x)y^{n+1} \exp(\int(1-n)p(x)dx = (1-n)\int[\exp\int(1-n)p(x)dx]Q(x)dx$.
20. Solve given differential equations.
21. Solve equations of the form (ax + by + c)dx + (ex + fy + g)dy = 0.

TEXT: Chapters 1 and 2

UNIT II: LINEAR EQUATIONS WITH CONSTANT COEFFICIENTS

THE STUDENT WILL SOLVE LINEAR EQUATIONS WITH CONSTANT COEFFICIENTS

1. Define a) $D^K u$ b)$(aD^K + bD^r)$ c) $(aD^K bD^r)u$
2. Prove: If f(D) is a polynomial then:
   a. $f(D)e^{mx} = e^{mx}f(m)$
   b. $(D-m)^K (x^k e^{mx}) = k!e^{mx}$

c. $(D-m)^n x^k e^{mx} = 0 \forall k < n$

3. Fine f(D)y for given f and y.
4. Write the general form of an nth order linear equation.
5. Prove: If y_1 and y_2 are solutions of f(D)y = 0, then $c_1y_1 + c_2y_2$ is a solution also.
6. Define linearly dependent and linearly independent.

7. State: If $f_1 \ldots f_n$

$f_1 \ldots f_n$ 0 then $\{f_1, \ldots, f_n\}$ is linearly independent.

(n-1) (n-1)

$f_1 \ldots f_n$

8. Determine whether a given set is linearly independent.
9. Explain why $y = c_1y_1 + \ldots + c_ny_n$ is the general solution to f(D)y = 0 if $\{y_1, y_2, \ldots, y_n\}$ is a set of linearly independent solutions of f(D)y = 0.
10. Prove: If $m_1, \ldots, m_n$ are distinct roots of f(m) = 0 then $y = c_1 e^{m x} + \ldots c_n e^{m x}$ is the general solution of f(D)y = 0, where f(D)y = 0 is of order n.
11. Prove: If be is a repeated root of f(m) = 0, say K times, then the part of the general solution of f(D)y = 0 corresponding to this root is $y = c_o e^{bx} + c_1 e^{bx} x + \ldots c_{k-1} e^{b} x^{k-1}$
12. State: If (a + ib) and (a - 1b) are repeated roots of f(m) = 0 K times, the part of the general solution of f(D)y = corresponding to these roots is
    y = $e^{ax} (c_0 + c_1 x + \ldots + c_{k-1} x^{k-1})$ sin bx +
    e (d +
    $e^{ax} (d_0 + d_1 x + \ldots + d_{k-1} x^{k-1})$ cox bx.
13. Solve given differential equations of the type of f(D)y = 0.
14. Prove if y_c is the general solution of f(D)y = 0 and y_p is any solution of f(D)y = R(x) then $y_c + y_p$ is the general solution of f(D) y = R(x).
15. Solve given differential equations of the type of f(D)y = R(x).

TEXT: 3-4

UNIT III LAPLACE TRANSFORMS

THE STUDENT WILL USE LAPLACE TRANSFORMS TO SOLVE DIFFERENTIAL EQUATIONS.

1. Define LaPlace Transform.
2. Find the LaPlace Transform of given functions.
3. Find the Inverse LaPlace Transform of given functions.
4. Solve given Differential Equations using LaPlace Transforms.

TEXT: Chapter 6

UNIT IV NUMERICAL METHODS

THE STUDENT WILL SOLVE DIFFERENTIAL EQUATIONS BY NUMERICAL METHODS.

1. Cauchy polygon
2. Three-Term Euler
3. Runge-Kutta

TEXT: Integrated throughout topics Chapter 8

UNIT V POWER SERIES SOLUTIONS

THE STUDENT WILL USE POWER SERIES TO SOLVE DIFFERENTIAL EQUATIONS.

1. Power Series
2. Alternate Method
3. Regular Singular Points
4. Bessel Equation

TEXT: Chapter 5

UNIT VI SYSTEMS OF EQUATIONS

THE STUDENT WILL SOLVE SYSTEMS OF DIFFERENTIAL EQUATIONS.

1.0 $\frac{dX}{dt} = A$

1.1 Assume solution in the form $X = e^{\lambda x} C$ where $C = \begin{bmatrix} C_1 \\ \\ C_n \end{bmatrix}$, scalar

1.2 Substituting (1.1) in (1.0) we have:

$\lambda e^{\lambda x} c = A e^{\lambda x C}$

$\lambda C = AC$

$AC - \lambda C = 0$

1.3

$$AC - \lambda C = (A - \lambda I)C = \begin{bmatrix} a_{11} - \lambda a_{12} \ldots\ldots\ldots a_{1n} \\ a_{21} a_{22} - \lambda \ldots\ldots\ldots a_{2n} \\ \\ . \\ . \\ . \\ a_{n1} a_{n2} \ldots\ldots\ldots a_{nn} - \lambda \end{bmatrix} \begin{bmatrix} C_1 \\ C_2 \\ . \\ . \\ . \\ . \\ C_n \end{bmatrix} = 0$$

1.4 A non-zero solution exists $|A - \lambda I| = 0$ = 0. This is the characteristic equation.

1.5 From (1.4) we have λ.

1.6 Substituting in (1.3) we have C.

1.7 Substituting in (1.1) we have $\{X_1, ..., X_n\}$ which are linearly independent.

1.8 $b_1X_1 + b_2X_2 + ... + b_nX_n = X$ is the general solution to (1.0)

TEXT: Chapters 7

UNIT VII APPLICATIONS

THE STUDENT WILL SOLVE GIVEN APPLICATION PROBLEMS.

1. Newton's laws of motion.
2. Gravitational attraction.
3. Simple Harmonic Motion.
4. The vibrating spring.
5. Damped vibrations.
6. Forced vibrations.
7. The deflection of beams.
8. Suspended cables.
9. Simple electric circuits.
10. Mixtures.
11. Decompositions.
12. Compound interest.

TEXT: Integrated throughout topics

This syllabus is subject to revision with prior notification to the student by the instructor.