COURSE DESCRIPTION FORM: MT-1006: Differential Equations

INSTITUTION: FAST School of Computing, National University of Computer and Emerging Sciences, Islamabad Campus

PROGRAM TO BE EVALUATED Cyber Security (BS- CY (A, B, C, D))-**Spring-2023**

Course Description

Course Code	MT-1006
Course Title	Differential Equations
Credit Hours	3
Course Instructors	Dr. Javaria Akram, Mr. Ahtsham ul Haq
Grading Policy	Absolute Grading
Policy about missed assessment items in the course	Retake of missed assessment items (other than sessional/ final exam) will not be held. Student who misses an assessment item (other than sessional / final exam) is awarded zero marks in that assessment item i.e., late submission will not be accepted. For missed sessional/ final exam, exam retake/ pre-take application along with necessary evidence are required to be submitted to the department secretary. The examination assessment and retake committee decide the exam retake/ pre-take cases.
Course Plagiarism Policy	Plagiarism in project or sessional/ final exam will result in F grade in the course. Plagiarism in an assignment will result in zero marks in the whole assignments category.
Prerequisites by Course(s) or Topics	Calculus and Analytical Geometry
Assessment Instruments with Weights (homework, quizzes, sessional exams, final exam, assignments, etc.)	Assessment with the weight.

Assessment Type	**Weight**
Assignments* (4)	05
Project	05
Quizzes (8)	10
Sessional I	15
Sessional II	15
Final Exam	50

*Assignments will be submitted in softcopy on Google Classroom and in hardcopy as well. Submission of softcopy and hardcopy is mandatory. If the assignment is not submitted in both forms, it will not be graded.

Course Coordinator	Dr. Javaria Akram
URL (if any)	-

Course Catalog Description	Infinite series, Power Series, Taylor Series and Maclaurin Series, Equation of line and Plane ,Multivariable functions, Limit and continuity in higher dimensions, Partial derivatives, Extreme values and their applications, Double integrals over rectangular and general regions, Triple integrals, Average value of a function in space, First order differential equations, solution of first order differential equations and its applications, Homogeneous linear equations of second order, general solution of the second order differential equations, non-homogenous linear equations, Solving system of linear DEs by elimination, Mathematical modeling of mass-spring system (free undamped motion and free damped motion), series solution of differential equations about ordinary points, Laplace transform and its application ,Solution of partial differential equations.
Textbook(s)	1. Thomas Calculus, 13th ed., by George B. Thomas Jr, Maurice D. Weir and Joel Hass, Pearson. 2. Differential Equations with Boundary Value Problems, 7th Edition by Dennis G. Zill & Michael R. Cullen.
Reference Material	**Calculus (Sixth Edition) By Swokowski**
Course Goals	**A. Course Learning Outcomes (CLOs)** After course completion, the students shall be able to: This course is a continuation of the prerequisite Calculus and Analytical Geometry to further develop and encourage students to think visually, analytically and numerically the real-world problems. Students will be able to explore and explain a variety of differential equations and calculus concepts and applications in writing exercises. After completion of the course, the student shall be able to: 1. Learn the infinite series, especially power series, Taylor and Maclaurin Series and their applications. 2. Understand several variable functions, partial derivatives, and double integrals. 3. Model and solve differential equations of several types arising from physical situations. 4. Compute Laplace Transforms of various functions and use it in solving differential equations (IVP) 5. Solve differential equations by using modern computing tools. **B. Program Learning Outcomes (PLOs)** For each attribute below, indicate whether this attribute is covered in this course or not. Leave the cell blank if the enablement is little or non-existent.

PLO 1	Computing Knowledge	Apply knowledge of mathematics, natural sciences, computing fundamentals, and a computing specialization to the solution of complex computing problems.	✔
PLO 2	Problem Analysis	Identify, formulate, research literature, and analyze complex computing problems, reaching substantiated conclusions using first principles of mathematics, natural sciences, and computing sciences.	✔
PLO 3	Design/Develop Solutions	Design solutions for complex computing problems and design systems, components, and processes that meet specified needs with appropriate	

		consideration for public health and safety, cultural, societal, and environmental considerations.	
PLO 4	Investigation & Experimentation	Conduct investigation of complex computing problems using research-based knowledge and research-based methods	
PLO 5	Modern Tool Usage	Create, select, and apply appropriate techniques, resources, and modern computing tools, including prediction and modelling for complex computing problems.	✔
PLO 6	Society Responsibility	Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, and cultural issues relevant to context of complex computing problems.	
PLO 7	Environment and Sustainability	Understand and evaluate sustainability and impact of professional computing work in the solution of complex computing problems	
PLO 8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of computing practice.	
PLO 9	Individual and Team Work	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.	✔
PLO 10	Communication	Communicate effectively on complex computing activities with the computing community and with society at large.	
PLO 11	Project Management and Finance	Demonstrate knowledge and understanding of management principles and economic decision making and apply these to one's own work as a member or a team.	
PLO 12	Life Long Learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological changes.	

C. Mapping of CLOs to PLOs
(CLO: Course Learning Outcome, PLOs: Program Learning Outcomes)

		PLOs											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CLOs	1	✔								✔			
	2	✔								✔			
	3	✔	✔			✔				✔			
	4	✔								✔			

		5	✔	✔			✔				✔			

Topics covered in the course
(assume 16-week instruction and 3 contact hours per week)

1. Topics to be covered:

List of Topics	No. of Weeks	Contact Hours	CLO(s)
Power Series (Radius of convergence, Interval of Convergence), Taylor Series and polynomials, Maclaurin Series, Equation of line and Plane, Functions of several variables, Domain range, Level curves, Limit and continuity in higher dimensions, Partial derivatives, Extreme values and their applications, Double integrals over rectangular and general regions, Triple integrals, Average value of a function in space.	5	15	1,2
First order differential equations, Solution of first order differential equations and its applications. Solution of ODE's using programming languages.	3	9	2,3
Homogeneous linear equations of second order, General solution of the second order differential equations, non-homogenous linear equations, solving system of linear DEs by elimination, (By hand solution and also by using programming languages).	3	9	3,5
Mathematical modeling of mass-spring system, series solution of differential equations about ordinary points (Also using programming languages), Laplace transform and its applications.	2.5	7.5	3,5
Introduction to PDEs and its solution.	2.5	7.5	4
Total	**16**	**48**	

Programming Language for Assignments (Instructor's Choice)	C++/Python/MATLAB/Mathematica

Class Time Spent (in percentage)	**Theory**	**Problem Analysis**	**Solution Design**	**Social and Ethical Issues**
	35	30	30	5
Oral and Written Communications	Every student is required to submit at least 01 written report of typically 5-10 pages.			

COURSE CONTENTS:		
Weeks	**Course Contents/Topics**	**Courseware Events** (Quiz/ Assigment/ Project)
Week 01	Power series (Radius of Convergence, Interval of Convergence), Maclaurin series and Taylor series, Taylor polynomials, Ex#10.8, Equation of line and Plane, Ex#12.5.	
Week 02	Continuation of Ex#12.5, Functions of several variables, Domain and range, Ex#14.1, Limit (two path test for non-existence of a limit) and continuity in higher dimensions, Ex#14.2, Partial derivatives.	Quiz # 1
Week 03	Continuation of Partial Derivatives, Ex#14.3, Extreme values and their applications Ex#14.7, Double integrals over rectangular and general regions, Ex #15.1 and Ex#15.2, Triple integrals.	Assignment # 1
Week 04	Continuation of the previous topic, Average value of a function in space, Examples and Ex#15.5.	Quiz # 2
Week 05	Definition and important terminologies of differential equations, Ex #1.1, Initial Value Problems, Ex#1.2.	Assignment # 2
Week 06	Differential Equations as Mathematical Models, Ex#1.3, Solution Curves without a Solution (Direction Fields, Autonomous First Order DEs), Ex#2.1, Separable Equations, Ex#2.2.	Sessional I
Week 07	Linear Equations, Ex#2.3, Exact Equations, Ex#2.4, Solution by Substitution, Ex#2.5.	Quiz # 3
Week 08	Solution of Linear Models, Ex#3.1, Preliminary theory—linear equations, IVP and BVP, Homogeneous and Non-Homogeneous Equations, Ex#4.1.	Assignment # 3
Week 09	Homogeneous linear equations with Constant Coefficients (General Solution, Real Roots, Complex Roots, Double Root of the Characteristic Equation), Ex#4.3, Undetermined Coefficients – Superposition approach, Ex#4.4, Undetermined Coefficients – Annihilator approach, Ex#4.5.	Quiz # 4
Week 10	Variation of Parameters, Ex#4.6, Cauchy-Euler Equations, Ex#4.7, Reduction of Order, Ex#4.2.	Assignment # 4
Week 11	Solving system of linear differential equations by Elimination, Ex4.8.	Quiz # 5
Week 12	Modeling with second order ODE of Mass-Spring System (Damped and Undamped Motion), Ex#5.1, Series solution of linear equation by Power series method (about ordinary points), Ex#6.1.	Sessional II
Week 13	Introduction to Laplace Transform, Ex#7.1, Inverse Transforms and Transforms of Derivatives.	Quiz # 6
Week 14	Solution of DE by Transform method, Ex#7.2, Introduction to Partial Differential Equations, Ex#12.1.	Project
Week 15	Solution of Heat Equation by Method of Separation of Variables, Ex#12.3, Solution of Wave Equation, Ex#12.4.	Quiz # 7
Week 16	Solution of Laplace's Equation, Ex#12.5.	Quiz # 8 Optional