National Computing Education Accreditation Council

COURSE DESCRIPTION FORM: [MT1006]: [Differential Equations]

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

PROGRAM(s) TO BE EVALUATED (BS-CS)-**Fall-2023**

Course Description

Course Code	MT-1006
Course Title	Differential Equations
Credit Hours	3
Prerequisites by Course(s) or Topics	Calculus and Analytical Geometry
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. A student who misses an assessment item (other than the sessional/final exam) is awarded zero marks in that assessment item i.e., late submission will not be accepted. For missed sessional/final exams, exam retake/ pre-take applications 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 a 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.
Attendance Policy	• Present – At the time of attendance. Attendance will be taken at the start of the lecture • Late – Within the first 10 minutes of the scheduled start of the lecture. Absent will be marked after 10 minutes. • Leaving the class for more than 5 minutes will result in absent status. Leaving the class without permission will result in absent status.
FLEX Queries	Queries related to FLEX entries (marks or attendance) should be raised within 24 hours of the entry. Queries raised after 24 hours will not be entertained, even if it is a valid query.
Assessment Instruments with Weights (homework, quizzes, sessional exams, final exam, assignments, etc.)	100% Theory

Assessment Items	Number	Weight (%)
Assignments*	4-6	8
Home Work	3-4	7
Quizzes	6-8	10
Project	0	00
Sessional I	1	25
Sessional II		
Final Exam	1	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 Instructors	Dr. Arfan Shahzad, Dr. Saima, Mr. M Munawar, Mr. M Shoaib, Mr. Sameer Munir
Course Coordinator	Dr. Arfan Shahzad
Course Catalog Description	Infinite series and its convergence, Power Series, Taylor Series, and Maclaurin Series, First order differentialequations, 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 the 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. Model and solve differential equations of several types arising from physical situations.
3. Compute Laplace Transforms of various functions and use it in solving differential equations (IVP)
4. Solve differential equations by using modern computing tools such as MATLAB.

C. Mapping of CLOs on 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 15-week instruction and 3 contact hours per week)	**List of Topics**	**No. of Weeks**	**Contact Hours**	**CLO(s)**
	Sequence and series, Convergence of the series by using the integral test, comparison test, Ratio and Root test, Alternate series, Power Series (Radius of convergence, Interval of Convergence), Taylor Series and polynomials, Maclaurin Series,	4.5	13.5	1,2
	First order differential equations, Solution of first-order differential equations and its applications. Solution of ODEs using MATLAB.	2.5	7.5	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 MATLAB).	3	9	3,5
	Mathematical modeling of the mass-spring system, Series solution of differential equations about ordinary points (Also using MATLAB), Laplace transform and its applications.	2.5	7.5	3,5
	Introduction to PDEs and its solution.	2.5	7.5	4
	Total	**15**	**45**	

Programming Language for Assignments	MATLAB			
Class Time Spent (in percentage)	**Theory (%)**	**Problem Analysis (%)**	**Solution Design (%)**	**Social and Ethical Issues (%)**
	35	30	30	5
Oral and Written Communications				

COURSE CONTENTS:

Weeks	**Contents/Topics**	**Courseware Events** (Quiz/ Assignment/ Project)
Week 01	10.1 Introduction to Sequence 10.2 Infinite Series	
Week 02	10.3 Integral Test 10.4 Comparison Test	Quiz#1

Week 03	10.5 Absolute Convergence, The ratio, and Root Test 10.6 Alternating Series and Conditional Convergence 10.7 Power Series 10.8 Taylor Series and McLaurin Series	Assignment#1 Quiz# 2
Week 04	2.1 Basic Concept, Formation, and Solution of differential equation by direct integration and by separating the variables' Direction Fields. 2.2 Separation variable	Assignment#2
Week 05	**Sessional – I**	
Week 06	2.3 Linear Differential Equations 2.4 Exact and non-Exact Differential Equations	
Week 07	2.5, Solution by Substitution, Equations (Homogeneous & Bernoulli's DE) Reduceable to the linear equation and Ricatti 3.1 1st order ODEs arising from Real life problems. 3.3 Solution of Linear Models,	Assignment# 3 Quiz# 3
Week 08	4.1 Preliminary theory—linear equations, IVP and BVP, Existence of unique solution, Homogeneous and Non-Homogeneous Equations, 4.2 Reduction of Order. Homogeneous linear dependence and independence with Constant Coefficients. Wronskian and non-homogeneous linear DE. 4.3 (General Solution, Real Roots, Complex Roots, Double Root of the Characteristic Equation)	Quiz# 4
Week 09	4.3 Continuation 4.4 Undetermined Coefficients–Superposition approach, 4.5 Undetermined Coefficients – Annihilator approach, 4.6 Variation of Parameters.	Assignment# 4
Week 10	**Sessional-II**	
Week 11	4.6 Continuation 4.7Cauchy-Euler Equations. 4.8 Solving system of linear differential equations by Elimination.	Quiz# 5
Week 12	12.1 Basic Concept and Formation of partial differential equations. Linear homogenous partial differential equations and relations to ordinary differential equations.	Assignment#5 Quiz# 6
Week 13	12.2 Classical Equation and Boundary value problems 12.3 Heat equation	
Week 14	12.4 Wave equation 12.5 Laplace equations	Quiz#7
Week 15	11.1 Orthogonal Functions 11.2 Fourier Series	
Week 16	11.3 Fourier Cosine and Sinne Series (Periodic functions and expansion of periodic function in Fourier series and Fourier Coefficient). 11.4 Sturm-Liouville Problems.	