CC-3/ MCC-4

Session: 2023-24	
Part A – Introduction	
Subject	Mathematics
Semester	III
Name of the Course	Differential Equations-1
Course Code	B23-MAT-301
Course Type: (CC/MCC/MDC/CC-M/ DSEC/VOC/DSE/PC/AEC/VAC)	CC
Level of the course	200-299
Pre-requisite for the course (if any)	Mathematics as a subject at 4.0 Level (Class XII)
Course Learning Outcomes(CLOs):	**After completing this course, the learner will be able to:** 1. Gain knowledge of the basic concepts of ordinary differential equations and learn various techniques of finding exact solutions of certain solvable first order differential equations. 2. Have procedural knowledge and cognitive and technical skills of solving homogeneous and non-homogeneous second order linear ordinary differential equations with constant coefficients and with variable coefficients. 3. Gain knowledge of theory of total differential equations and basic concepts of partial differential equations. To learn methods and techniques for solving linear PDEs of first order and to acquire technical skills

	for accomplishing assigned tasks relating to formulation and solution of PDEs in broad multidisciplinary contexts. 4. Have knowledge of concepts and theories of second order PDEs and to apply theory of PDEs to determine integral surfaces through a given curve and to find orthogonal surfaces. To understand compatible systems and to learn cognitive and technical skills required for selecting and using relevant Charpit method, Jacobi method methods to assess the appropriateness of approaches for solving PDEs.
CLO 5 is related to the practical component.	5. To attain cognitive and technical skills required for selecting and using relevant methods and techniques to assess the appropriateness of approaches to solving problems associated with the differential equations. To attain technical skill of solving differential equations by using built in functions of MAXIMA software.

	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Examination Marks	50	20	70
Examination Time	3 Hours	3 Hours	

Max. Marks:100

Part B- Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5

questions, selecting one question from each unit and the compulsory question.		
Unit	**Topics**	**Contact Hours**
I	Basic concepts and genesis of ordinary differential equations, Order and degree of a differential equation, Solutions of differential equations of first order and first degree, Exact differential equations, Integrating factor, First order higher degree equations solvable for x, y and p, Lagrange's equations, Clairaut's form and singular solutions. Orthogonal trajectories of one-parameter families of curves in a plane.	12
II	Solutions of linear ordinary differential equations with constant coefficients, linear non-homogeneous differential equations. Linear differential equation of second order with variable coefficients. Method of reduction of order, method of undetermined coefficients, method of variation of parameters. Cauchy-Euler equation.	12
III	Solution of simultaneous differential equations, total differential equations. Genesis of Partial differential equations (PDE), Concept of linear and non-linear PDEs. Complete solution, general solution and singular solution of a PDE. Linear PDE of first order. Lagrange's method for PDEs of the form: $P(x, y, z)\, p + Q(x, y, z)\, q = R(x, y, z)$, where $p=\partial z/\partial x$ and $q=\partial z/\partial y$.	12
IV	Integral surfaces passing through a given curve. Surfaces orthogonal to a given system of surfaces. Compatible systems of first order equations. Charpit's method, Special types of first order PDEs, Jacobi's method. Second Order Partial Differential Equations with Constant Coefficients.	12

	Practical	
	The practical component of the course has two parts, Problem Solving and Practical's using MAXIMA software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (COs) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program. **(A) Problem Solving-** Questions related to the following problems will be solved and record of those will be maintained in the Practical Notebook: 1. Problems solving for differential equations which are reducible to homogeneous. 2. Problems solving for differential equations which are Exact differential equations. 3. Problems solving for linear differential equations with constant coefficient. 4. Problems solving for linear differential equations with variable coefficient. 5. Problems solving for differential equations by method of variation of parameters. 6. Problems solving for differential equations by method of undetermined coefficients. 7. Problems solving for simultaneous differential equations. 8. Problems solving for different PDEs using Lagrange's method. 9. Problems solving for PDEs with Charpit's method and Jacobi's	30

	method. **(B)The following practicals will be done using MAXIMA software and record of those will be maintained in the practical note book:** 1. Solutions of first and second order differential equations. 2. Plotting of family of solutions of differential equations of first, second and third order. 3. Solution of differential equations using method of variation of parameters. 4. Growth and decay model (exponential case only). 5. Lake pollution model (with constant/seasonal flow and pollution concentration). 6. Density-dependent growth model. 7. Predatory-prey model (basic Volterra model, with density dependence, effect of DDT, two prey one predator). 8. To find the solutions Linear differential equations of second order using built in functions of MAXIMA software. 9. To find numerical solution of a first order ODE using plotdf built in function of MAXIMA. 10. To find exact solutions of first and second order ODEs using ode2 and ic1/ic2 built in functions of MAXIMA. 11. To find exact solutions of first and second order ODEs using desolve and atvalue built in functions of MAXIMA.	
➢ **Suggested Evaluation Methods**		
Internal Assessment: ➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:		**End Term Examination:** ➢ **Theory 50** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write up and execution of the program
Part C-Learning Resources		

Recommended Books:

1. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10th edition). J. Wiley & Sons.
2. B. Rai & D. P. Choudhury (2006). *Ordinary Differential Equations - An Introduction*. Narosa Publishing House Pvt. Ltd. New Delhi.
3. Shepley L. Ross (2014). *Differential Equations* (3rd edition). Wiley India Pvt. Ltd.
4. George F. Simmons (2017). *Differential Equations with Applications and Historical Notes* (3rd edition). CRC Press. Taylor & Francis.
5. Ian N. Sneddon (2006). *Elements of Partial Differential Equations*. Dover Publications.