Semester	**6**
Course	**Major-3**
Paper Code	
Paper Title	**Differential Equations-II**
No. of Credits	**4**
Theory / Practical / Composite	**Theory**
Minimum No. of preparatory hours per week a student has to devote	**4**
Number of Modules	**Nil**
Syllabus	**Dynamical systems [12]:** Introduction to Continuous Dynamical Systems, Autonomous and Non-Autonomous Systems. Critical points and their classification. Interpretation of the phase plane. Phase trajectory, Phase space and its Interpretation, phase diagram in one variable, idea of local equilibrium, Source, and sink. Local Stability Analysis. Critical points in 2 dimension and their classification. Stability Analysis. Trace Det Diagram. **Introduction to Mathematical Biology [12]:** Application to single-species population growth model: Malthusian, Verhulst-Pearl Model, Allee effect. Epidemic models like the SI, SIS, and SIR models of Kermack and McKendrick, with an introduction to COVID-19. Lotka-Volterra Prey-Predator model without competition and with competition, Battle model of Richardson. **ODE [14]:** Sturm-Liouville problems. Total differential equations: conditions of integrability, exactness and techniques of solving them **(6)**. Power series solution at an ordinary point and Frobenius series solution at a regular singular point **(8).** **First Order PDE [4]**: Classification, Construction and Geometrical Interpretation. Method of Characteristics for obtaining a general Solution of quasi-linear equations. Canonical Forms of First-order Linear Equations. Method of Separation of Variables for solving first-order partial differential equations. **Second order PDE [10]:** Classifications, Transformation of PDE to Canonical form, Characteristics Equation and Characteristics curve. Study of Initial value problem and Cauchy problems and their Existence and uniqueness of solutions, Cauchy-Kovalevskaya theorem, Hadamard rule for well-posed problems. Superposition principle.

Learning Outcomes	On successful completion of the course, a student will be able to do the following: • Understand the fundamentals of continuous dynamical systems, classify critical points, and analyze stability through phase plane methods, phase diagrams, and trace–determinant techniques. • Apply dynamical systems theory to mathematical biology models, including single-species growth models (Malthusian, Verhulst–Pearl, Allee effect), epidemic models (SI, SIS, SIR), predator-prey models, and the Richardson battle model. • Solve Sturm–Liouville problems and total differential equations by verifying integrability conditions and applying exact solution techniques. • Develop power series solutions of ODEs around ordinary points and apply the Frobenius method for solving equations at regular singular points. • Classify and solve first-order PDEs using canonical forms, the method of characteristics, and separation of variables. • Analyze second-order PDEs by classification and transformation to canonical form, solve Cauchy and initial value problems, and apply results such as the Cauchy- Kovalevskaya theorem and Hadamard's well-posedness rule.	
Reading/Reference Lists	1. **Differential Equations and Boundary Value Problems**: Edwards and Penney. 2. **An Introduction to Dynamical Systems and Chaos**: G.C.Layek. 3. **Differential Equations, Dynamical Systems, and an Introduction to Chaos**: Morris W. Hirsch, Robert L. Devaney, and Stephen Smale. 4. **Linear Partial Differential Equations for Scientists and Engineers**: Tyn Myint U and Lokenath Debnath. 5. **An elementary Course in Partial differential Equations**: T.Amarnath.	
Evaluation	**End Sem**: 70 **CIA**: 30(20(MidSem)+5(Assignment) + 5(Attendance))	
Paper Structure for Theory Semester Exam	7 questions each carrying 10 marks out of 13/14 questions.	