

**National Conference on Advanced Research in Science,
Engineering, Management and Humanities****(NCARSEMh – 2025)****27th July, 2025, Jharkhand, India.****CERTIFICATE NO : NCARSEMh /2025/ C0725754****An Evaluation of Dynamic Behavior and Complex Bifurcations in
Nonlinear Second-Order Difference Equations****Purushottam Kumar**

Research Scholar, Ph.D. in Mathematics, P.K. University, Shivpuri, M.P., India.

ABSTRACT

Nonlinear second-order difference equations provide an important mathematical framework for studying systems whose states evolve in discrete time and whose future behavior depends on both present and previous states. The dynamic behavior of such systems can include equilibrium states, periodic oscillations, bounded solutions, instability, and more complicated patterns. This seminar focuses on evaluating these behaviors with particular emphasis on bifurcation phenomena arising from nonlinear terms. Bifurcation analysis examines how qualitative changes in system dynamics occur when one or more parameters are varied. In nonlinear second-order difference equations, small changes in system parameters may lead to transitions from stable equilibrium to periodic solutions, oscillatory behavior, or complex dynamics. Exponential nonlinearities are especially significant because they can produce strong sensitivity to parameter variations and generate rich dynamical structures. The study considers equilibrium points, local stability, characteristic equations, parameter-dependent stability conditions, and the occurrence of different types of bifurcations. Numerical simulations and graphical representations can further illustrate trajectories, phase patterns, periodic orbits, and transitions toward complex behavior. Such analysis helps explain the relationship between nonlinear parameters and system stability.