

Title: Modulation instability analysis, and characterize time-dependent variable coefficient solutions in electromagnetic transmission and biological field

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Abstract: This study integrates the telegraph model with the traveling wave coefficient. This model characterizes planar random motion of particles in fluid flow, pressure waves from pulsatile blood flow in arteries, electrical impulses in nerve and muscle cell axons, and electromagnetic waves in superconducting media. Using the efficient and well-established Enhanced Modified Simple Equation (EMSE) method, we investigate solitary wave solution with the variable coefficient of the telegraph model. To investigate the variable coefficient solitary wave solution, we apply a transformation variable $\eta = h(t)x + g(t)$, which is dependent on the time variable function. The diverse functions of $h(t)$ and $g(t)$ yield many novel and exclusive solutions. Numerical solutions are plotted in 3D, density, and 2D. instanton soliton, kinky periodic wave, lump wave, kink wave, anti-kink wave, double periodic wave, diverse types periodic wave, lump with bell wave periodic wave, periodic lump wave, etc. Solitary waves explain complex wave phenomena through nonlinear effects like self-interaction and dispersion. Due to the classical nonlinear telegraph model's wave dynamics, they are used in brain function and communication system design. We conclude by testing the governing model's modulation instability. Dispersive and nonlinear processes modulating the stable state cause instability in high-order nonlinear equations. Examining the wave movement role and modulation instability analysis to assess solution stability shows that all solutions are accurate and stable. The computational difficulties and results demonstrate the approaches' clarity, effectiveness, and simplicity, suggesting they can be applied to evolutionary dynamic and static nonlinear equations in computational physics, other real-world situations, and numerous academic

Keywords: Modulation instability, EMSE method, Telegraph model, Exact solutions, Superconducting media, Electromagnetic waves

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