

**Spectral matrix for the time delay control in the steady state bifurcation analysis of  
viscoelastic system represented by fractional derivatives**

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The harmonic balance (HB) method substitutes time by Fourier coefficients and therefore replaces the nonlinear ODE to nonlinear algebraic equations. The bifurcation analysis can then be carried out on the nonlinear algebraic equations. However, HB can hardly deal with irrational nonlinearity, fractional derivatives and time delay and the number of effective Fourier terms cannot be determined in the beginning. Changing the number of terms invokes complete recalculation. A new spectral matrix for the steady state analysis of periodic system is proposed. It is found that the method is very effective for investigating systems having time delay, fractional derivatives and nonlinear inertia and damping.

**Keywords:** Spectral matrix; time delay; periodic bifurcation; viscoelasticity; fractional derivatives; nonlinear inertia; nonlinear damping.