A 5-point-stencil optimised nonlinear scheme with spectral-like resolution within the whole wave number range for secondary derivatives is devised. The proposed scheme can compensate for the dissipation deficiency of traditional linear schemes and suppress the spurious energy accumulation that occurs at high wave numbers, both of which are frequently encountered in large eddy simulation. The new scheme is composed of a linear fourth-order central scheme term and an artificial viscosity term. These two terms are connected by a nonlinear weight. The proposed nonlinear weight is designed based on Fourier analysis, rather than Taylor analysis, to guarantee a spectral-like resolution. Moreover, the accuracy is not affected by the optimisation, and the new scheme reaches fourth-order accuracy. The new scheme is tested numerically using the one-dimensional diffusion problem, one-dimensional steady viscous Burger's shock, two-dimensional vortex decaying, three-dimensional isotropic decaying turbulence and fully developed turbulent channel flow. All the tests confirm that the new scheme has spectral-like resolution and can improve the accuracy of the energy spectrum, dissipation rate and high-order statistics of turbulent flows.