We construct a high order numerical approach based on a uniform mesh for solving the time-fractional diffusion equation of fractional order α where $0<\alpha<1$. Time fractional diffusion equations occur when attempting to describe transport processes with long memory where the rate of diffusion is not consistent with Brownian motion. The time-fractional derivative is discretized by means of Caputo's fractional derivative. The resulting set of equations is discretized by using a collocation approach based on quartic B-spline basis function. The unconditional stability of the scheme is analysed using Von-Neumann stability analysis method. Two examples are provided to demonstrate the accuracy and applicability of the method. Numerical results confirm that the proposed method is of the order $O(k^{2-\alpha}+h^2)$ where h is the mesh size with respect to the space variable and k is the mesh size with respect to the time variable. In order to show the advantage of the new method, the obtained results have been compared with those reported previously in the literature.