L-Fractional Derivative and Mechanics: Theory and Applications

A.K.Lazopoulos

Evelpidon Hellenic Army Academy, Department of Military Sciences

Sector of Mathematics and Engineering Applications

Applied Mechanics Laboratory

Abstract. This presentation is an attempt to present a meaningful Mechanics formulation into the context of Fractional Calculus. The main problem that Fractional Calculus faces is that the existing fractional derivatives do not form a meaningful differential. Indeed, that leads to erroneous and meaningless quantities like fractional velocity and fractional strain. In reality those quantities, alter the dimensions of the physical quantities. In fact the dimension of the fractional velocity is L/T^{α}, contrary to the conventional *L/T*. Likewise, the dimension of the fractional strain is $L^{-\alpha}$, contrary to the conventional L^0. Therefore, since physical equations are described primarily in differentials and not in derivatives the definition of fractional derivatives that correspond to differentials is of paramount importance. One such derivative that tackles this problem is the L-Fractional derivative. Since such a derivative is defined, many aspects of the Mechanics theory may be reformulated and expressed in a physically and mathematically meaningful way. The main feature of that derivative is non-locality in time (memory) and space (neighbourhood non-uniformities), therefore it is most suitable to express global and not local phenomena. Starting from viscoelasticity, we explore the Zener relaxation model using the L-Fractional derivative while we compare experimental to theoretical data. Moreover fractional tension of a rod and fractional bending of a beam will be analyzed.