EXISTENCE AND LOCALIZATION OF HARMONIC AND SUB-HARMONIC SOLUTIONS OF SECOND ORDER NON - LINEAR DIFFERENTIAL EQUATION [18]

§ 1.1 Introduction

An important problem in the theory of non-linear differential equations or (non-linear oscillations) is the existence of periodic solutions. Since the earlier work of Poincaré [43] until now, the subject received much attention from many investigators for example, Urabe [57,58,59], Levinson [30], Lefschetz [29], Cartwright and Littlewood [4], Kryloff and Bogoliuboff[28], Coddington and Levinson [8], Choy-Tak-Taam [7], Hale [22,23,24], Cesari [5], Tomas and Tondl [55], Schmitt [49], Elnaggar [11], Elnaggar and Elbouhy [14], Elnaggar and Hamad-Allah [16], Peter Girg [42], Mehri and Shadman [34].

There exist many topological or analytical methods, which are available for proving the existence of periodic solutions of certain systems of differential equations, for example, the Isocline method, Delta method (it is more applicable to equation with oscillatory solutions), Lienard's method (it is most conveniently used to deal with what are called self-excited oscillations, but it is also applicable in other cases), the Index method of poincaré [43] and the fixed point method of Brouwer [4].