Various biological and physiological properties of living tissues can be studied by means of NMR techniques. However, the basic physics of extracting the relevant information from the solution of Bloch NMR equations to accurately monitor the clinical state of biological systems is still not fully understood. Presently, there are no simple closed solutions known to the Bloch equations for a general RF excitation. Therefore, an exponential type of solution of the equations presented in this study, which can be taken as definitions of new functions to be studied in detail, may reveal very crucial information from which various NMR flow parameters can be derived. In this study, we are concerned with finding a solution of the form to the Equations. We shall restrict our attention to cases where the radio frequency field can be treated by simple analytical methods. First, we shall derive a time-dependent second-order non-homogenous linear differential equation from the equations in term of the equilibrium magnetization Mo, RF B1(t) field, T1 and T2 relaxation times. Then, we would solve the differential equation for the cases when RF B1(t) = 0, and when RF B1(t) ≠0.

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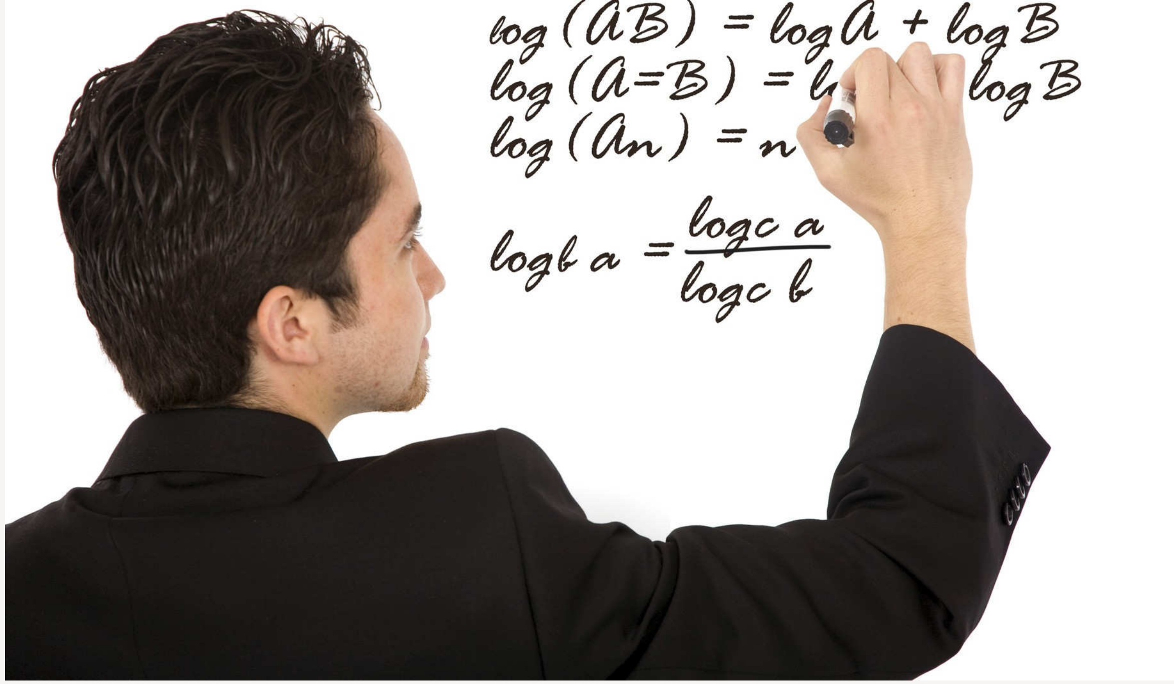

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DEDICATION

This project is dedicated to the Almighty God and my loving family.

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ABSTRACT

Various biological and physiological properties of living tissues can be studied by means of nuclear magnetic resonance (NMR) techniques. However, the basic physics of extracting the relevant information from the solution of Bloch nuclear magnetic resonance (NMR) equations to accurately monitor the clinical state of biological systems is till not fully understood. Presently, there are no simple closed solutions known to the Bloch equations for a general RF excitation. Therefore, an exponential type of solution of the Bloch NMR equations presented in this study, which can be taken as definitions of new functions to be studied in detail, may reveal very crucial information from which various NMR flow parameters can be derived. Fortunately, many of the most important but hidden applications of blood flow parameter can be revealed without too much difficulty if appropriate mathematical techniques are used to solve the equations. In this study, we are concerned with finding a solution of the form $e^{\lambda x+\mu y}$ to the Bloch NMR flow Equations. We shall restrict our attention to cases where the radio frequency field can be treated by simple analytical methods. First, we shall derive a time-dependent second-order non-homogenous linear differential equation from the Bloch NMR equations in term of the equilibrium magnetization M_o, RF $B_1(t)$ field, T_1 and T_2 relaxation times. Then, we would solve the differential equation for the cases when RF $B_1(t) = 0$, and when RF $B_1(t) \neq 0$. This would allow us to obtain the intrinsic or natural behaviour of the NMR system as well as the response of the system under investigation to a specific influence of external force to the system. Specifically, we consider the case where the RF B_1 varies harmonically with time. Here, the complete motion of the system consists of two parts. The first part describes the motion of the transverse magnetization M_y in the absence of RF $B_1(t)$ field (that is, $B_1(t) = 0$). The second part of the motion is described by the particular integral of the derived differential equation which does not decay with time but continues its periodic behaviour indefinitely.

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