ABSTRACT

This thesis deals with the new methods for computing the commuting and non-commuting the matrix exponential and some other related conditions. It shall be organized in seven chapters as follows.

Chapter One, entitled "**Exponential Matrix and General Properties**", presents a definition of the matrix exponential in general, presenting another form of such a matrix exponential. In this chapter, the researcher shall pay much more attention to the matrix exponential, its properties, and some theorems, which are very important in this regard. Finally, previous studies related to the current research would be presented and highlighted.

Chapter Two, entitled "**Exact Calculation of the Matrix Exponential**", contains some methods for computing the matrix exponential for a generally complex matrix. These methods are based on eigenvalues and eigenvectors. Discussions have been done to determine the best method to compute the matrix exponential theoretically, highlighting the studies that are on different methods for the computation of matrix exponential and their accuracy. Different methods along with several examples have been given to show that each method has particular strengths and weaknesses.

In Chapter Three, "**New Method to Calculate the Matrix Exponential**", a new method has been provided to compute the

matrix exponential**.** In such a method, the same established methods and procedures have been followed and adopted, but the eigenvalues of A are not needed for the construction of e^A, since most of our results have used only the coefficients of the polynomial w, where w are the Horner polynomials. The canonical forms or spectral decompositions of matrices have not been used. By way of concluding this chapter, some examples have been provided to show how the respective procedures work for this method.

Chapter Fourth, "**A New Method to Compute Commuting and Non Commuting Exponential Matrix**", includes a new method to compute commuting and non commuting exponential matrix that has been used**,** where the matrix exponential is in $M(2,R)$. Some theorems to verify this method have been highlighted and presented.

In Chapter Five, "**Some Conditions Regarding to Commuting and Non Commuting Exponential Matrix**", some conditions regarding to commuting and non commuting exponential matrix have been presented. In this chapter, the conditions for which this equation $e^{A+B} = e^A e^B = e^B e^A$ is valid in $M(2,R)$ have been defined by the researcher. He also towards the end of this chapter has defined the form of matrices that verify the above equation.

In Chapter Six, "**A New Approach to Compute the Exponential Matrix for Some Special Matrices**", a new method to compute the matrix exponential e^{tA} where the matrix A has an eigenvalues $\lambda_1 = 0$ has been introduced. This method is an effectiveness method to compute the accurate solution of e^{tA} where the matrix A satisfies this condition $A^n = \omega_1 A^{n-1} + \omega_2 A^{n-2}, A \in C^{n\times n}$, Where ω_1 *and* ω_2 are parameters.

Chapter Seven, "**Conclusion**", presents the findings of the current research, presenting some suggestions for further studies.