

**SOLVING NONLINEAR SYSTEM OF EQUATION BASED ON  
MATLAB GUI**

**MUHAMMAD AZRI BIN AZMAN SHAH**

**Thesis submitted in fulfilment  
of the requirement for the degree of  
Bachelor of Science (Hons.)  
Mathematical Modelling and Analytics**

**College of Computing, Informatics and Mathematics  
Universiti Teknologi Mara**

**July 2024**

## ABSTRACT

Nonlinear systems are prevalent in numerous scientific and engineering fields, presenting unique challenges due to their complex behavior and the potential for multiple solutions. The numerical methods implemented in this project include Newton's Method, Broyden's Method, the Broyden-Fletcher-Goldfarb-Shanno (BFGS) Method, the Steepest Descent (SD), and Fsolve method. The main objectives of this project were to review the results of applying the Newton, Broyden, BFGS, SD, and Fsolve methods to the numerical solution of a system of nonlinear equations and to create a user-friendly MATLAB GUI that simplifies the process for users. The solver accepts user inputs for functions, jacobians, and initial values, and outputs the number of iterations, norm of gradients to reach a solution. Extensive testing was conducted using ten standard test functions to evaluate the performance of each method. The results demonstrate that while Newton's Method generally converges faster, Broyden's and BFGS Methods offer computational advantages in scenarios where the Jacobian matrix is challenging to compute. The SD Method, although slower, provides reliable convergence for specific types of problems. This project not only highlights the strengths and weaknesses of each numerical method but also contributes a practical tool for researchers and engineers to solve complex nonlinear systems efficiently. The developed MATLAB GUI stands out for its ease of use, visual appeal, and adaptability to various applications, making it a valuable addition to the computational tools available in mathematical modelling and analytics.

## **ACKNOWLEDGEMENT**

First and foremost, I would like to express my deepest gratitude to Allah, the Most Gracious and Most Merciful, for providing me with the strength, knowledge, and perseverance to complete this project. Without His blessings, this work would not have been possible.

I am profoundly grateful to my supervisor, Dr. Nur Idalisa binti Norddin, for her invaluable guidance, support, and encouragement throughout the duration of this project. Her insightful feedback and continuous motivation were instrumental in shaping the direction and outcome of my research.

I would also like to extend my heartfelt thanks to my parents for their unwavering love, support, and sacrifices. Their belief in my abilities and constant encouragement have been the driving force behind my academic achievements.

Furthermore, I am thankful to all the participants involved in this project. Their cooperation and contributions were crucial in the successful completion of my research.

Thank you all for your support and assistance.

## TABLE OF CONTENTS

DECLARATION BY THE SUPERVISOR .....	i
DECLARATION BY THE CANDIDATE.....	ii
ABSTRACT.....	iii
ACKNOWLEDGEMENT .....	iv
LIST OF TABLES .....	viii
LIST OF FIGURES .....	ix
INTRODUCTION OF RESEARCH .....	1
1.1    Introduction.....	1
1.2    Background of Study .....	1
1.3    Problem Statement.....	2
1.4    Objectives .....	3
1.5    Significance of Project.....	3
1.6    Scope of Project .....	4
1.7    Project Benefits.....	5
1.8    Definition of Terms and Concepts .....	6
1.9    Organization of Project.....	7
LITERATURE REVIEW.....	9
2.1    Introduction.....	9
2.2    Nonlinear System.....	9
2.3    Importance of Solving Nonlinear System.....	10
2.4    Solution Algorithm.....	11
2.4.1    Newton Method .....	11
2.4.2    Broyden Method .....	12

2.4.3	Steepest Descent Method.....	13
2.4.4	BFGS Method.....	13
2.5	Fsolve.....	16
2.6	MATLAB GUI.....	17
2.7	Conclusion.....	17
METHODOLOGY.....		18
3.1	Introduction.....	18
3.2	Research Step.....	18
3.3	GUI Solver.....	21
3.4	Test Function.....	22
3.5	Conclusion.....	23
IMPLEMENTATION.....		24
4.1	Introduction.....	24
4.2	Solution Algorithm.....	24
4.2.1	Newton Method.....	24
4.2.2	Broyden Method.....	27
4.2.3	BFGS Method.....	33
4.2.4	SD Method.....	36
4.2.5	Fsolve.....	40
4.3	Conclusion.....	43
RESULT AND DISCUSSION.....		44
5.1	Introduction.....	44
5.2	Result and Analysis.....	44
5.3	MATLAB Result.....	44
5.3.1	Fsolve Result.....	45