

Task 3(A) Bisection Method

	Method	Time_Taken	Total_Iters	Total_Error	Total_Error_Diff
1	"Original"	2.1904	141949	1.5070	1.2999
2	"Bisection"	1.0760	1960	2.8068	1.2999

Headings Explanation:

- Method: Refers to the script in question, original is the provided script for task 3 whilst bisection is completed work for task 3 using bisection method.
- Time_Taken: Method run time duration using “tic-toc”.
- Total_Iters: Total cumulative sum of each methods iteration count.
- Total_Error: Total cumulative sum of each methods errors.
- Total_Error_Diff: The total cumulative sum of difference in errors between the method (value is the same).

Summary:

From this table, the bisection method ran twice as quickly as the original script, however, the accuracy (due to the higher error) is lower. Run time is significantly reduced due to the 139989-iteration difference.

Task 3(b) Solving Techniques

Method	Type of Solver	Overview	Ease of Use	Efficiency	Accuracy	Suitability	Total	Reference
Gaussian Elimination	Linear Equation Solver	Linear solver, not that useful for this application due to some non-linear equations. Uses matrices to solve equations.	3	4	4	2	13	[1]
fsolve	MATLAB non-linear solver	Used to solve a system of non-linear equations in symbolic math toolbox.	4	3	4	5	16	[2] [3]
fzero	Matlab non-linear root solver.	Built in Matlab function that is used to root solve a non-linear function.	3	4	4	4	15	[4]
eliminate	Matlab symbolic function eliminating variable	Eliminate is a symbolic toolbox function that eliminates a specified variable within a set of rational equations (rearranging to equal zero).	3	4	4	3	14	[5]
solve	Matlab Symbolic Toolbox solver for equations	Solve is the default symbolic toolbox equations and system solver, it solves for specified variables from specified equation(s).	4	3	5	5	17	[6]

Note 1 is worst, 5 is best.

From this data, “solve” will be taken forward to attempt to solve the chemical balancing equation for n5. It is also worth considering the “fsolve” function and “fzero”, where the root finding application would be useful. According to the author of the dissertation this task is associated with, the accuracy of these solvers is questionable and does not meet the required standards for two zone combustion modelling, therefore the dedicated iterative elimination solver in the function “mydissfun” was constructed to achieve a tolerance/accuracy of 1×10^{-12} .

References

- [1] Zill, D., Wright, W. and Cullen, M. (2011) *Advanced Engineering Mathematics*. United Kingdom: Jones & Bartlett Learning.
- [2] MATHWORKS (n.d.). *fsolve, Matlab Help Centre*. Mathworks. Available at: <https://uk.mathworks.com/help/optim/ug/fsolve.html> (Accessed: 18 January 2025).
- [3] MATLAB (n.d.). *Options for Solving a System of Non-linear Equations, Matlab Help Centre Community*. Mathworks. Available at: <https://uk.mathworks.com/matlabcentral/answers/1805095-options-for-solving-a-system-of-non-linear-equations> (Accessed: 18 January 2025).
- [4] MATHWORKS (n.d.). *fzero, Matlab Help Centre*. Mathworks. Available at: <https://uk.mathworks.com/help/matlab/ref/fzero.html> (Accessed: 18 January 2025).
- [5] MATHWORKS (n.d.). *Eliminate, Matlab Help Centre*. Mathworks. Available at: <https://uk.mathworks.com/help/symbolic/sym.eliminate.html> (Accessed: 17 January 2025).
- [6] MATHWORKS (n.d.). *solve, Matlab Help Centre*. Mathworks. Available at: <https://uk.mathworks.com/help/symbolic/sym.solve.html> (Accessed: 18 January 2025).