Vol.09 Issue-01, (January - June, 2017) ISSN: 2394-9309 (E) / 0975-7139 (P)
Aryabhatta Journal of Mathematics and Informatics (Impact Factor- 5.856)

APPLICATIONS OF GAUSS-ELIMINATION AND GAUSS-JORDAN METHODS”

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Abstract

This paper aims to investigate the applications of Gauss Elimination and Gauss Jordan methods.

1. INTRODUCTION:

The field of numerical analysis predates the invention of modern computers by many centuries. Linear Interpolation was already in use more than 2000 years ago. Many great mathematicians of the past were preoccupied by numerical analysis, as is obvious from the names of important algorithms like Newton's method, Lagrange interpolation polynomial, Gaussian elimination, or Euler's method.

To facilitate computations by hand, large books were produced with formulas and tables of data such as interpolation points and function coefficients. Using these tables, often calculated out to 16 decimal places or more for some functions, one could look up values to plug into the formulas given and achieve very good numerical estimates of some functions. The canonical work in the field is the NIST publication edited by Abramowitz and Stegun, a 1000-plus page book of a very large number of commonly used formulas and functions and their values at many points. The function values are no longer very useful when a computer is available, but the large listing of formulas can still be very handy.

The mechanical calculator was also developed as a tool for hand computation. These calculators evolved into electronic computers in the 1940s, and it was then found that these computers were also useful for administrative purposes. But the invention of the computer also influenced the field of numerical analysis, since now longer and more complicated calculations could be done.

Numerical analysis is the area of mathematics and computer science that creates, analyzes, and implements algorithms for solving numerically the problems of continuous mathematics. Such problems originate generally from real-world applications of algebra, geometry and calculus, and they involve variables which vary continuously; these problems occur throughout the natural sciences, social sciences, engineering, medicine, and business. During the past half-century, the growth in power and availability of digital computers has led to an increasing use of realistic mathematical models in science and engineering, and numerical analysis of increasing sophistication has been needed to solve these more detailed mathematical models of the world. The formal academic area of numerical analysis varies from quite theoretical mathematical studies to computer science issues. With the growth in importance of using computers to carry out numerical procedures in solving mathematical models of the world, an area known as scientific computing or computational science has taken shape during the 1980s and 1990s. It is concerned with using the most powerful tools of numerical analysis, computer graphics, symbolic mathematical computations, and graphical user interfaces to make it easier for a user to set up, solve, and interpret complicated mathematical models of the real world.

The overall goal of the field of numerical analysis is the design and analysis of techniques to give approximate but accurate solutions to hard problems, the variety of which is suggested by the following:

- Advanced numerical methods are essential in making numerical weather prediction feasible.
- Computing the trajectory of a spacecraft requires the accurate numerical solution of a system of ordinary differential equations.
- Car companies can improve the crash safety of their vehicles by using computer

- simulations of car crashes. Such simulations essentially consist of solving partial differential equations numerically.
- Hedge funds (private investment funds) use tools from all fields of numerical analysis to attempt to calculate the value of stocks and derivatives more precisely than other market participants.
- Airlines use sophisticated optimization algorithms to decide ticket prices, airplane and crew assignments and fuel needs. Historically, such algorithms were developed within the overlapping field of operations research.
- Insurance companies use numerical programs for actuarial analysis.

Numerical analysis is the study of algorithms that use numerical approximation (as opposed to general symbolic manipulations) for the problems of mathematical analysis (as distinguished from discrete mathematics).

One of the earliest mathematical writings is a Babylonian tablet from the Yale Babylonian Collection (YBC 7289), which gives a sexagesimal numerical approximation of the square root of 2, the length of the diagonal in a unit square. Being able to compute the sides of a triangle (and hence, being able to compute square roots) is extremely important, for instance, in astronomy, carpentry and construction.

Numerical analysis continues this long tradition of practical mathematical calculations. Much like the Babylonian approximation of the square root of 2, modern numerical analysis does not seek exact answers, because exact answers are often impossible to obtain in practice. Instead, much of numerical analysis is concerned with obtaining approximate solutions while maintaining reasonable bounds on errors.

Numerical analysis naturally finds applications in all fields of engineering and the physical sciences, but in the 21st century also the life sciences and even the arts have adopted elements of scientific computations. Ordinary differential equations appear in celestial mechanics (planets, stars and galaxies); numerical linear algebra is important for data analysis; stochastic differential equations and Markov chains are essential in simulating living cells for medicine and biology.

Before the advent of modern computers numerical methods often depended on hand interpolation in large printed tables. Since the mid 20th century, computers calculate the required functions instead. These same interpolation formulas nevertheless continue to be used as part of the software algorithms for solving differential equations.

The aim of this paper is to investigate the methods of solving system of non-linear equations using Gauss elimination method and Gauss Jordan method, to finding out application of the methods to other fields of study.

2. GAUSS ELIMINATION AND GAUSS JORDAN METHODS

2.1 Introduction to Gauss-Elimination

The process of Gaussian elimination has two parts. The first part (forward elimination) reduces a given system to either triangular or echelon form, or results in a degenerated equation with no solution, indicating the system has no solution. This is accomplished through the use of elementary row operations. The second step uses back substitution to find the solution of system of linear equation.

Stated equivalently for matrices, the first part reduces a matrix to row echelon form using elementary row operations while the second reduces it to reduced row echelon form. Another point of view which turns out to be very useful to analyze the algorithm is that Gaussian elimination computes matrix decomposition. The 3 elementary row operations used in the Gaussian elimination (multiplying rows, switching rows and adding multiples of rows to other rows) amount to multiplying matrix with invertible matrix from the left**.**

2.2 Introduction to Gauss-Jordan

In matrix analysis and linear algebra, Carl DNIeyor (2000), writes "Although there has been some confusion as to which Jordan should receive credit for this algorithm, it is seems clear that the method was in fact introduced by a geodesist named Wilhelm Jordan (1842-1899) and not by the more well known mathematician Marie Ennemond Camille Jordan (1838-1992), whose name is often mistakenly associated with the technique, but who is otherwise correctly credited with other important topic in matrix analysis, the Jordan Canonical form being the most notable". Having identified the right Jordan is not the end of the problem, for A.S. Household writes, in the theory of matrices in numerical analysis (1964) "The Gauss-Jordan method, so called seems to have been described first by Clasen (1888) since it can be regarded as a modification of Gaussian elimination, the name Gauss is properly applied, but that of Jordan seems to be due to an error, since the method was described only in the third edition of his Hanbuch der VermesSungskunde, prepared after his death". These claims were examined by S.C. Althoen and R. Mcluaghlin (1987). They concluded that Household was correct about Clasen and his 1888 publication but mistaken about Jordan who was very much alive when the third edition of his book appeared in 1888. They added that the "germ of the idea" was already present in the second edition of 1877 (This entry was contributed by John Aldrich).

2.3 The Gauss- Eliminaion and Gauss-Jordan Methods Of Solving System Of Linear Equations

A system of linear equations (or linear system) is a collection of linear equation involving the same set of variables. A solution of a linear system is an assignment of values to the variable

$x_1, x_2, x_3,..., x_n$ equivalently, $\{x_i\}^n$ i= 1 such that each of the equation is satisfied. The set of all possible solutions is called the solution set.

A linear system solution may behave in any one of three possible ways:

1. The system has a infinitely many solutions
2. The system has a single unique solution
3. The system has no solution.

For three variables, each linear equation determines a plane in three dimensional space and the solution set is the intersection of these planes. Thus, the solution set may be a line, a single point or the empty set.

For variables, each linear equation determines a hyperplane in n-dimensional space. The solution set is the intersection of these hyper-planes, which may be a flat of any dimension. The solution set for two equations in three variables is usually a line.

In general, the bahaviour of a linear system is determined by the relationship between the number of equations and the number of unknowns. Usually, a system with fewer equations than unknowns has infinitely many solutions such system is also known as an **undetermined system**. A system with the same number of equation and unknowns has a single unique solution. A system with more equations than unknowns has no solution. There are many methods of solving linear system which include: Substitution methods, elimination methods, matrix inversion methods, graphical methods, crammer's methods, Gaussian elimination methods, Gauss-Jordan elimination methods etc. In this paper, the Gauss and Gauss-Jordan shall be considered.

2.4 Gauss Elimination Method

Gaussian elimination is a systematic application of elementary row operations to a system of linear equations in order to convert the system to upper triangular form. Once the coefficient matrix is in upper triangular form, we use back substitution to find a solution. The general procedure for Gaussian elimination can be summarized in the following steps: -

- Write the augmented matrix for the system of linear equation.
- Use elementary operation on {A/b} to transform A into upper triangular form. If a zero is located on the diagonal, switch the rows until a non zero is in that place. If you are unable to do so, stop; the system has either infinite or no solution.
- Use back substitution to find the solution of the problem.

Consider the system of equation in matrix form below.

$$\begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = \begin{pmatrix} b_1 \\ b_2 \\ b_3 \end{pmatrix}$$

Step 1: Write the above as augmented matrix

$$\begin{pmatrix} a_{11} & a_{12} & a_{13} : b_1 \\ a_{21} & a_{22} & a_{23} : b_2 \\ a_{31} & a_{32} & a_{33} : b_3 \end{pmatrix}$$

Step 2: Eliminate x_1 from the 2nd and 3rd equations by subtracting multiples $m_{21} = \dfrac{a_{21}}{a_{11}}$ *and* $m_{31} = \dfrac{a_{31}}{a_{11}}$ of row 1 from rows 2 and 3 producing equivalent system:

$$\begin{pmatrix} a_{11} & a_{12} & a_{13} & : & b_1 \\ 0 & a_{22}^{(2)} & a_{23}^{(2)} & : & b_2^{(2)} \\ 0 & a_{32}^{(2)} & a_{33}^{(2)} & : & b_3^{(2)} \end{pmatrix}$$

Step 3: Eliminate $x2$ from $3rd$ equation by subtracting multiples $m_{32} = \frac{a_{32}{}^{(2)}}{a_{22}{}^{(2)}}$ of row 2 from row 3 producing matrix system:

$$\begin{pmatrix} a_{11} & a_{12} & a_{13} & : & b_1 \\ 0 & a_{22}{}^{(2)} & a_{23}{}^{(2)} & : & b_2{}^{(2)} \\ 0 & 0 & a_{33}{}^{(2)} & : & b_3{}^{(3)} \end{pmatrix}$$

Example:

$x_1+2x_2-3x_3=3$
$2x_1-x_2-x_3=11$
$3x_1+2x_2-x_3=-3$

This can be written as,

$$\begin{pmatrix} 1 & 2 & -3 \\ 2 & -1 & -1 \\ 3 & 2 & 1 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = \begin{pmatrix} 3 \\ 11 \\ -5 \end{pmatrix}$$

The augmented matrix becomes

$$\begin{pmatrix} 1 & 2 & -3 & : & 3 \\ 2 & -1 & -1 & : & 11 \\ 3 & 2 & 1 & : & -5 \end{pmatrix}$$

Now subtract $\frac{2}{1}$ times the first row from the second row and times $\frac{3}{1}$ the first row from the third row and times which gives;

$$\begin{pmatrix} 1 & 2 & -3 & : & 3 \\ 0 & -5 & 5 & : & 5 \\ 0 & -4 & 10 & : & -14 \end{pmatrix}$$

Now subtract $\frac{-4}{-5}$, i.e. $\frac{4}{5}$ times the second row from the third row. Then we have

$$\begin{pmatrix} 1 & 2 & -3 : & 3 \\ 0 & -5 & 5 : & 5 \\ 0 & 0 & 6 : & -18 \end{pmatrix}$$

Note that as a result of these steps, the matrix of co efficient of x has been reduced to a triangular matrix.
Finally, we detach the right-hand column back to its original position:

$$\begin{pmatrix} 1 & 2 & -3 \\ 0 & -5 & 5 \\ 0 & 0 & 6 \end{pmatrix}\begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = \begin{pmatrix} 3 \\ 5 \\ -18 \end{pmatrix}$$

Then by 'back substitution', starting from the bottom row we get:

$$x_1 = 2; x_2 = -4; x_3 = -3$$

2.5 Gauss-Jordan Method

Gauss-Jordan elimination is a modification of Gaussian elimination. Again we are transforming the coefficient matrix into another matrix that is much easier to solve and the system represented by the new augmented matrix has the same solution set as the original system of linear equations. In Gauss-Jordan elimination, the goal is transform the coefficient matrix into a diagonal matrix and the zeros are introduced into the matrix one column at a time. We work to eliminate the elements both above and below the diagonal elements of a given column in one passes through the matrix. The general procedure for Gauss-Jordan elimination can be summarized in the following steps:

i. Write the augmented matrix for a system of linear equation
ii. Use elementary row operation on the augmented matrix [A/b] to the transform A into diagonal form. If a zero is located on the diagonal. Switch the rows until a non-zero is in that place. If you are unable to do so, stop; the system has either infinite or no solution.
iii. By dividing the diagonal elements and a right-hand side's element in each row by the diagonal elements in the row, make each diagonal elements equal to one.

Given a system of equation 4 x 4 matrix of the form:

$$\begin{pmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{pmatrix}\begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix} = \begin{pmatrix} b_1 \\ b_2 \\ b_3 \\ b_4 \end{pmatrix}$$

Step 1: Write the above as augmented matrix, we have

$$\begin{pmatrix} a_{11} & a_{12} & a_{13} & a_{14} : b_1 \\ a_{21} & a_{22} & a_{23} & a_{24} : b_2 \\ a_{31} & a_{32} & a_{33} & a_{34} : b_3 \\ a_{41} & a_{42} & a_{43} & a_{44} : b_4 \end{pmatrix}$$

Step 2: Eliminate x_1 from the 2nd and 3rd and 4th equation by subtracting multiples $m_{21} = \frac{a_{21}}{a_{11}}, m_{31} = \frac{a_{31}}{a_{11}}$ *and* $m_{41} = \frac{a_{41}}{a_{11}}$ of row 1, from 2, 3 and 4 respectively producing

$$\begin{pmatrix} a_{11} & a_{12} & a_{13} & a_{14} & : b_1 \\ 0 & a_{22}^{(2)} & a_{23}^{(2)} & a_{24}^{(2)} & : b_2^{(2)} \\ 0 & a_{32}^{(2)} & a_{33}^{(2)} & a_{34}^{(2)} & : b_3^{(2)} \\ 0 & a_{42}^{(2)} & a_{43}^{(2)} & a_{44}^{(2)} & : b_4^{(2)} \end{pmatrix}$$

Step 3: Eliminate x_2 from the 1st, 3rd and 4th equation by subtracting multiples $m_{21} = \frac{a_{12}}{a_{22}^{(2)}}, m_{32} = \frac{a_{32}^{(2)}}{a_{22}^{(2)}}$ *and* $m_{42} = \frac{a_{42}^{(2)}}{a_{22}^{(2)}}$ of row 2 from row 1, 3 and 4 to produce

$$\begin{pmatrix} a_{11}^{(3)} & 0 & a_{13}^{(3)} & a_{14}^{(3)} : b_1^{(3)} \\ 0 & a_{22}^{(2)} & a_{23}^{(2)} & a_{24}^{(2)} : b_2^{(2)} \\ 0 & 0 & a_{33}^{(3)} & a_{34}^{(3)} : b_3^{(3)} \\ 0 & 0 & a_{43}^{(2)} & a_{44}^{(3)} : b_4^{(3)} \end{pmatrix}$$

Step 4: Eliminate x_3 from the 1st, 2nd and 4th equations by subtracting multiples

$$m_{13} = \frac{a_{13}^{(3)}}{a_{33}^{(3)}}, m_{23} = \frac{a_{23}^{(3)}}{a_{33}^{(3)}}, m_{43} = \frac{a_{43}^{(3)}}{a_{33}^{(3)}} \text{ of row3 from row1, 2 and 4 producing}$$

$$\begin{pmatrix} a_{11}^{(4)} & 0 & 0 & a_{14}^{(4)} & : b_1^{(4)} \\ 0 & a_{22}^{(4)} & 0 & a_{24}^{(4)} & : b_2^{(4)} \\ 0 & 0 & a_{33}^{(3)} & a_{34}^{(3)} & : b_3^{(3)} \\ 0 & 0 & 0 & a_{44}^{(4)} & : b_4^{(4)} \end{pmatrix}$$

From which we finally solve for x_1, x_2, x_3 and x_4 from the resulting simultaneous equations.

Example:

$$\begin{pmatrix} 1 & 2 & -3 \\ 2 & -1 & -1 \\ 3 & 2 & 1 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = \begin{pmatrix} 3 \\ 11 \\ -5 \end{pmatrix}$$

The augmented matrix becomes

$$\begin{pmatrix} 1 & 2 & -3 & : 3 \\ 2 & -1 & -1 & : 11 \\ 3 & 2 & 1 & : -5 \end{pmatrix}$$

We now eliminate x_1 from the 2nd and 3rd equation by subtracting multiple

$$m_{21} = \frac{a_{21}}{a_{11}} = 2, m_{31} = \frac{a_{31}}{a_{11}} = 3$$

Of row 1 from row 2 and 3 respectively producing.

$$\begin{pmatrix} 1 & 2 & -3 & : 3 \\ 0 & -5 & 5 & : 5 \\ 0 & -4 & 10 & : -14 \end{pmatrix}$$

Eliminate x_2 from 1st and 3rd equation by subtracting multiple

$$m_{12} = \frac{a_{12}}{a_{22}} = \frac{-2}{5}, and\ m_{32} = \frac{a_{32}}{a_{22}} = \frac{4}{5}$$

Of row 2 from row 1 and row 3

We have

$$\begin{pmatrix} 1 & 0 & -1 & : & 5 \\ 0 & -5 & 5 & : & 5 \\ 0 & 0 & 6 & : & -18 \end{pmatrix}$$

Eliminate x_3 from 1st and 2nd equation by subtracting multiple

$$m_{13} = \frac{a_{13}}{a_{33}} = \frac{-1}{6}, and\ m_{23} = \frac{a_{23}}{a_{33}} = \frac{5}{6}$$

Of row 3 from row 1 and row 3 $\begin{pmatrix} 1 & 0 & 0 & : & 2 \\ 0 & -5 & 0 & : & 20 \\ 0 & 0 & 6 & : & -18 \end{pmatrix}$

3. APPLICATIONS OF GAUSS-ELIMINATION AND GAUSS-JORDAN METHODS OF SOLVING SYSTEM OF LINEAR EQUATIONS

Gauss and Gauss-Jordan methods of solving system of linear equations can be used in various and (4) by subject areas and are used to solve for unknowns. With n equations, the highest possible number of unknowns that can be solved for is n. complications occur when the number of unknowns is unequal to the number of equations in the system.

Linear system of equations with more or less equations than unknowns occurs quite often. When there are fewer equations than unknowns, it is impossible solve for all the unknowns algebraically. Because of this, there usually infinite many solutions for each variable (it is hard to narrow it down). When there are more equations than unknowns (an over determined system), there are usually no solutions. This occurs because there may be solution that satisfy two of the three equations, but not necessarily all three. The only way there will be solution to an over determined system (for example, one with three equations and two unknowns) would be if all the equations are equivalent, if two of the three equations are equivalent and the other equation intersects each other at a single point.

Some of the areas where Gauss and Gauss-Jordan method can be applied are Business and Economics, Physics, Biology, Chemistry, Engineering etc.

- **Application in Business**

Gauss and Gauss-Jordan methods of solving linear system can be used in Business Education. As a matter of fact Business and Economics are interrelated.

Bolade Nig-Limited a garment industry manufactures three shirts styles. Each shirt requires the services of three departmental stores shown below.

	STYLES		
	A	**B**	**C**
Cutting	**0.2**	**0.4**	**0.3**
Sewing	**0.3**	**0.5**	**0.4**
Packaging	**0.1**	**0.2**	**0.1**

The cutting, sewing and packaging have available maximum of 1160, 1560 and 480 hours repressively. You are required to:

i. Formulate the information into linear equation forms.
ii. Using Gaussian and Gauss-Jordan elimination methods to find the number of shirt that must be produced each week for the plant to operate at full capacity.

Let x represents style A

Let y represents style B

Let z represents style C

$0.2x + 0.4y + 0.3z = 1160 \qquad (i)$

$0.3x + 0.5y + 0.4z = 1560 \qquad (ii)$

$0.1x + 0.2y + 0.1z = 480 \qquad (iii)$

Solving yields x =1200,y=800 and z=2000 (all in units)

- **Application in Economics**

Gauss and Gauss-Jordan methods can be used to find the equilibrium price and quantity to be supplied in a given market. Let's say there are two products: orange juice and water which are interrelated. Let P1 and qi represents the price and quantity demanded respectively for product 1 (orange juice) and P1 and q2 represents the same for product 2 (water).

Demand supply

Product 1: p, = 2000 - 3q1 - 2q2, q1 = 100 + 2q1 +q2

Product 2: P2 = 2800 - q, - 4q2, q2 = 200 + 3q1 +2q2

For equilibrium to be achieved, both price expressions must be equal, so the following equations are obtained.

Product 1: 2000 - 3q1 - 2q2=100 + 2q1 +q2

Product 2 : 2800 - q1 - 4q2=200 + 3q, + 2q2

The above expressions when rammed and solved

give q1=200, q2 = 300.

Hence P1 = N800, P2 = N1,400.

Finding the equilibrium price and quantity in a market is very important to an Economist since beyond these values, nothing will be sold at a profit.

Similar problems as above can occur or be j' formulated and both Gauss and Gauss-Jordan 0-methods can be readily applied.

Solving system of linear equations

The first and most important application of Gauss Jordan elimination method is for finding the solution of systems of linear equations which is applied throughout the mathematics.

❖ **Finding determinant**

The Gaussian elimination can be applied to a square matrix in order to find determinant of the matrix

❖ **Finding inverse of matrix**

The Gauss-Jordan elimination method can be used in determining the inverse of the square matrix. If M be an n X n square matrix and its inverse exists (since it is not necessary that each matrix has inverse matrix), then row reduction method can be used to compute inverse of such matrix.

❖ **Finding Ranks and Bases**

The Ranks as well as Bases of Square matrices can be computed by Gaussian elimination method using reduced row echolon form.

❖ **Most powerful tool of Numerical analysis**

- Computer Graphics
- Symbolic Mathematical Computations
- Graphical User Interface.

Numerical Analysis is needed to solve engineering problems that lead to equations that cannot be solved analytically with simple formulas.

Examples are solutions of large systems of algebraic equations, evaluation of interties and solutions of differential equations. The finite element method is a **numerical method** that is widespread use to solve partial differential equations in a variety of engineering fields including stress analysis, fluid dynamics, heat transfer and electro-magnetic fields.

- Computational Physics
- Computational Electromagnetic
- Computational Fluid Dynamics (CFD)
- Numerical method in Fluid Mechanics
- Large eddy Simulation
- Smoothed particle hydrodynamics
- Aero acoustic analogy – used in numerical aero acoustics to reduce sound sources to simple emitter types.
- Stochastic Eulerianlargangian method – uses eulerian description for fluids and largangian for structures
- Explicit Algebraic stress model
- Computational magneto hydrodynamics(CMHD) – studies electrically conducting fluids
- Climate model
- Numerical Weather Prediction
- Geodesic grid
- Celestial mechanics
- Numerical model of the solar system
- Quantum jump method – used for simulating open quantum systems
- Dynamic design analysis method (DDAM)- for evaluating effect of underwater explosion on equipment
- Computational chemistry
- Cell lists
- Coupled cluster
- Density functional theory
- DIIS – Direct Inversion in (or of) the iterative subspace.
- **Gauss Elimination Method**

Advantages:

- It is direct method of solving linear simultaneous equations
- It uses back substitutions
- It reduced to equivalent upper triangular matrix

It requires right vectors to be known.

Gauss Jordan Method

Advantages:

- It is direct method
- The roots of the equation are found immediately without using back substitution
- It is reduced to equivalent identity matrix

The additional step increase round off errors

It require right vectors to be known.

4. CONCLUSION

The study has concluded that when performing calculation by hand, Gauss-Jordan method is more preferable to Gaussian elimination version because it avoids the need for back substitution. Besides, it was noted very remarkably that both Gauss elimination method and Gaussian-Jordan elimination method gave the same answers for each worked example and both with pivoting and partial pivoting equally gave the same answers. This necessarily implies that since the system of linear equations still remains the same despite that the equations are re-arranged leading to its matrix form to be transformed as the rows' elements obviously changed, the resultant solutions are still the same. The importance of Gauss and Gauss-Jordan elimination method cannot be over emphasized due to its relevance to different field of studies (pure Science i.e. Physics, Biology, Chemistry, Mathematics etc. social science i.e. Economics, Geography, Business Education etc.

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