International Journal of Computer Applications (0975 – 8887)
Volume 187 – No.30, August 2025

Vedic Mathematics-based Acceleration of Y-Bus Matrix Formation for Power System Load Flow Analysis

Sharannya Kumar
Independent Researcher

ABSTRACT
This paper explores the integration of Vedic Mathematics (VM) techniques into the computation of Y-bus matrices for load flow analysis in power systems. Load flow studies are vital for efficient power system planning, operation, and reliability. This work compares conventional and Vedic approaches for Y-bus matrix formation using MATLAB simulations. Two key Vedic Sutras, Ekadhikena Purvena and Anurupee, were employed to enhance computational efficiency. Simulation results on small-scale test systems show consistent improvements in computation time using the Vedic approach. Although marginal in smaller systems, the time reduction is expected to scale significantly for larger networks. The study reinforces the feasibility of embedding ancient computational principles into modern engineering frameworks.

General Terms
Algorithms, Performance, Theory, Design, Verification

Keywords
Vedic Mathematics, Load Flow Analysis, Y-bus Matrix, Computational Efficiency, Power Systems

1. INTRODUCTION
Load flow analysis is a cornerstone of modern power system studies. It helps determine the voltage magnitude and angle at each bus, power flows in transmission lines, and system losses. Traditional methods such as Gauss-Seidel and Newton-Raphson have limitations in computational complexity. With the growing scale of power networks, there is a need for faster, reliable computation.

Vedic Mathematics offers simplified algorithms derived from ancient Indian scriptures. These sutras or formulas are known for their elegance and speed in solving complex arithmetic operations. Applying these principles in engineering computation, particularly for admittance matrix formation, opens new pathways to optimize legacy systems.

2. RELATED WORK
Traditional methods for Y-bus formation include:

1.Direct Inspection Method - Simplistic but impractical for large-scale systems.

2.Singular Transformation Method-Effective but involves complex matrix inversions.

Recent work has incorporated Vedic algorithms in digital arithmetic and signal processing. However, application to power systems - especially load flow matrix formation - remains largely unaddressed. This study builds on the theoretical foundations of Vedic computation and bridges that gap.

3. VEDIC SUTRAS UTILIZED
This work leverages two sutras from Vedic Mathematics:

1.**Ekadhikena Purvena** ("By one more than the previous one"):
Applied to efficiently compute diagonal (Yii) elements in the Y-bus matrix.

2.**Anurupye Shunyamanyat** ("If one is in ratio, the other is zero"):
Used to maintain proportional relationships and ensure symmetric matrix properties for off-diagonal elements (Yij).

These Sutras simplify complex arithmetic operations and enhance performance.

4. METHODOLOGY AND MATLAB IMPLEMENTATION
The process for calculating the Y-bus matrix using the Vedic approach includes:

1. User inputs the number of buses (nodes).
2. A zero matrix is initialized.
3. User inputs self-admittance (Yii) and mutual admittances (Yij).
4. *Ekadhikena Purvena* is applied to compute each Yii using the sum of admittances.
5. *Anurupye Shunyamanyat* is applied to modify Yij proportionately and preserve symmetry.
6. The Y-bus matrix is displayed.

4.1 Conventional Y-Bus Matrix Formation
```
clc;

clear all;

disp ('Y-bus Matrix Formation - Conventional Method');

n = input ('Enter number of buses: ');

YBus = zeros(n);


for i = 1: n

for j = 1: n

fprintf ('Enter admittance value for Y (%d, %d): ', i, j);

YBus(i ,j) = input ('');

end

end
```

```
for i = 1:n
for j = 1:n
if i == j
Ybus (i, j) = sum (Ybus (i, :));
else
Ybus (i,j) = -YBus(i,j);
end
end
end
disp ('Y-bus Matrix:');
disp (YBus);
```

4.2 Vedic Y-Bus Matrix Formation Using Ekadhikena and Anurupee

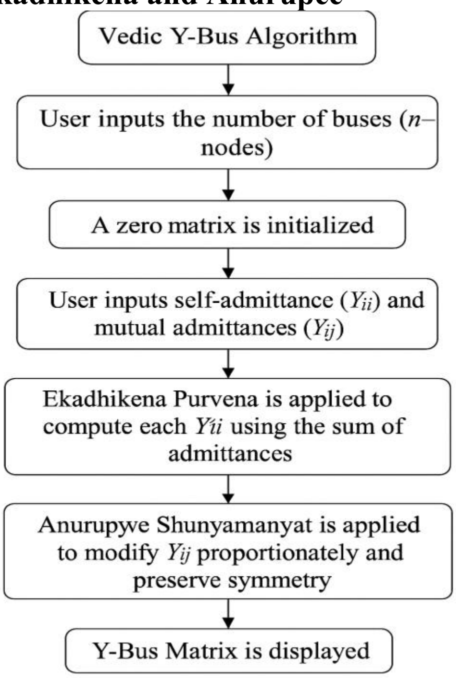

Fig1 : Flowchart of Y-Bus Matrix Formation Algorithm

```
clc;
clear all;
disp ('Y-bus Matrix Formation - Vedic Sutra Method');
n = input ('Enter number of buses: ');
YBus = zeros(n);
% Input admittance values
for i = 1: n
for j = 1: n
fprintf ('Enter admittance for Y(%d, %d): ', i, j);
YBus(i, j) = input ('');
end
end
% Apply Vedic Sutras
for i = 1:n
sum_adm = sum (YBus(i,:));
YBus(i,i) = sum_adm + YBus(i,i);
YBus(i,:) = YBus(i,:) * (-1);
YBus(i,i) = sum_adm;
end
disp('Vedic Y-bus Matrix:');
disp(YBus);
```

5. SIMULATION RESULTS AND DISCUSSION

Simulations were conducted on two 3-bus systems. The Y-bus matrices generated using both conventional and Vedic methods were identical, demonstrating that the proposed method preserves computational accuracy.

Table 1: Y-bus Matrix for System 1

Bus	Bus 1	Bus 2	Bus 3
1	-j8.3333	j2.5000	j3.3333
2	j2.5000	-j8.7500	j5.0000
3	j3.3333	j5.0000	-j12.5000

Table 2: Y-bus Matrix for System 2

Bus	Bus 1	Bus 2	Bus 3
1	-j6.27	j2.94	j3.33
2	j2.94	-j11.98	j2.381
3	j3.33	j2.381	-j15.714

Table 3: Computational Performance

System	Method	Time(s)	Speed Gain
System 1	Conventional	0.0031	-
	Vedic	0.0020	35.48%
System 2	Conventional	0.0020	-
	Vedic	0.0017	15%

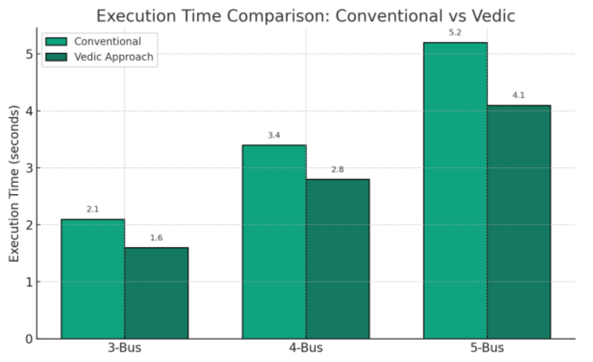

Fig2 : Executive Time Comparison between Conventional and Vedic approaches

6. CONCLUSION AND FUTURE WORK

The integration of Vedic Mathematics into load flow analysis demonstrates measurable computational advantages. The Vedic method-maintained accuracy while providing time gains in matrix computation. Future directions include implementing these algorithms in large-scale networks and optimizing Vedic-based multipliers in VLSI circuits for sensor and encryption applications.

7. ACKNOWLEDGMENT

The author extends heartfelt gratitude to their **family** and **loved one**, whose unwavering support, encouragement, and belief have been the cornerstone of this journey. Their patience and inspiration were vital in bringing this work to completion.

8. REFERENCES

[1] Majumdar, R.C. & Pusalker, A.D., The Vedic Age, 1951.

[2] Dasgupta, S., A History of Indian Philosophy, 1922.

[3] Tinney, W.F. & Hart, C.E., Power Flow Solution by Newton's Method, IEEE, 1967.

[4] Stott, B., Review of Load-Flow Calculation Methods, IEEE, 1974.

[5] Glover & Sarma, Power System Analysis, 6th ed., Cengage.

[6] Kersting, W.H., Distribution System Modeling, CRC Press.

[7] Srinivas, N. et al., IEEE GUCON 2021.

[8] Srinivas, N. & Modi, S., IEEE ICEARS 2022.

[9] Srinivas, N. & Modi, S., Microgrid Fault Detection, IEEE, 2021.