TRANSIENT STABILITY ANALYSIS OF NINE BUS POWER SYSTEM NETWORK

A Project report is submitted in partial fulfillment of the requirements for the award of Degree of Bachelor of Science in Electrical and Electronic Engineering.

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DECLARATION

This is due to the fact that this thesis entitled "**TRANSIENT STABILITY ANALYSIS OF NINE BUS POWER SYSTEM NETWORK**" is performed by the following students under my direct supervision and this work perform by PSAF Software. It is proof that it has been performed in partial compliance for the requirements of the Bachelor's Degree. Paper titled " **TRANSIENT STABILITY ANALYSIS OF NINE BUS POWER SYSTEM NETWORK** ". Submitted by **Md. Jakaria Mahafuj, ID:191-33-905, Dewan Md. Nahidul Islam; ID: 191-33-882**; section: Spring 2023 was recognized as sufficient to partially fulfill the requirements to obtain a BSc in Electrical and Electronic Engineering on 20 February 2023.

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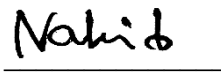

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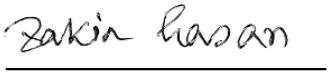

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Dedicated

To

Our teachers & Parents

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LIST OF ABBREVIATIONS

MVA	Megavolt-amperes
DIU	Daffodil International University
KV	Kilovolt
KW	Kilowatt
MW	Megawatt
PSAF	Power System Analysis Framework
AGC	Automatic Generation Control
EEE	Electrical and Electronic Engineering
CYME	Industrial and Transmission Network Analysis
NLDC	National Load Dispatch Centre
SCADA	Supervisory control and data acquisition

LIST OF SYMBOLS

Symbol	Name of the symbol
μ	mu
δ	Delta
V_i, V_n, V_{in}	Magnitude of the phase
θ_{in}, δ_n, δ_i	Phase Angle

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ABSTRACT

Modern energy systems are complex due to the highly interconnected networks of thousands of buses and production stations. Due to economic and environmental constraints on the installation of new generators and increasing load demand, transmission on existing lines increases. After that, the frequency fluctuates suddenly. Then, black-out occurs in the whole power system. This paper has been focused on voltage and frequency stability analysis. CYME PSAF software has been implemented as a real virtual laboratory for load flow and stability analysis. The Newton-Raphson method is a fast computational application. which is used in PSAF. The simulated data obtained from PISF is fully consistent with the real-time data. After simulation, it helps to reduce line loss, frequency loss, and mismatch, various countermeasures. A reasonable reduction in line loss and mismatch, therefore, represents a performance gain.

Keywords: Load flow, CYME PSAF, Mathematical parameters, Newton Raphson, Line Losses, Swing Bus, Generation loss etc.

CHAPTER 1
INTRODUCTION

1.1 Background

Power flow studies are of great importance in planning and designing the future expansion of power system as well as in determining the best operation of the existing systems [1]. If there is an imbalance between generation and demand, the frequency will deviate from the nominal value. If demand is high than generation then the frequency will be low. Otherwise, if demand is low than generation then the frequency will be high. In Bangladesh, frequency fluctuates mainly because of fuel shortages, the high rate of generator failure, and the low conductivity of the transmission line due to the use of the oldest main transmission line [2].

There are basically three methods used to control the frequency: Primary, secondary and tertiary but the Bangladesh lacks sufficient support to implement secondary and tertiary methods [2]. The main control is the action of the governor, which is mostly disabled in Bangladesh. The frequency is therefore highly unstable, uncertain and unreliable. The electricity frequency in Bangladesh routinely varies between 48.9 and 51.2 Hz on a normal day, sometimes rising from 50.2 to 51.5 Hz. There is still no effective control. So many consequences have suffered before. Grid malfunctions have occurred, including a significant blackout on November 1st, 2014 that affected the entire country. October 4, 2022, will see a blackout. Also, occurs a blackout in 75-80% of Bangladesh on October 4 due to the grid malfunction. Industrial machinery and electrical equipment suffer shortened life due to fluctuating frequency [9]. It causes huge economical losses to occur in Bangladesh.

The ultimate goal is to find out the causes of power system instability and then solve them. Their frequency is almost 50±0.5 Hz. So to secure, a stable power system is necessary.

1.2 Problem Statement and /or Proposed solution(s)

If every exciter in PSAF is in the ON mode, a simulation run error happens. While simulating, around 15 generator exciters can be allowed to turn ON simultaneously [2]. All generators' exciters must be ON in a real system.

when a load is increased or generation loss, PSAF considers those as a global load increase or indirect load increase. Similarly, while the load is decreased or generation is increased, PSAF considers it as a global load decrease or indirect load decrease. However, things do not work out this way in real life. There is a specific reason why the load changes, not a global one.

According to our assumptions, output results are monitored for 1 minute or 3000 cycles for each occurrence (such as a 200MW load increase), and PSAF software can only display output results for a maximum of 1 minute.

1.3 Objectives

The PSAF (Power System Analysis Framework) program generates a 1-minute frequency and voltage curves, after analyzing load flow and transient stability. After that, by analyzing the power flow and transient stability, it is shown that the frequency and voltage settlement can be greatly improved and is verifiable. Our objective is to find out which method can improve the frequency and voltage to its nominal value. Also, our objective is to find out the percentage change in load and generation that increases the voltage and frequency to its nominal value.

In CYME PSAF software, data is analyzed, and shows that frequency and voltage can be improved by adding or removing generators and loads.

PSAF detects overload conditions on power system lines and other equipment. Also, it detects abnormal conditions in the power system [1]. NLDC receives data from SCADA and operates it manually and gives commands if any load shedding is required. So following our actions and results will help our energy system a lot.

1.4 Methodology

1.4.1 Load flow analysis

Load flow analysis is the most important thing for power system planning, design, and operation [9]. It is used to determine the steady-state performance of the system under various possible operating conditions. It also helps in planning future expansion to keep

pace with the load. The magnitude and phase angle of the voltage at each bus as well as the real and reactive power flowing in each line is obtained from the power-flow study. In PSAF, the Newton-Raphson method is used for load flow analysis because the rate of convergence characteristic and solution algorithm robustness is high then the other method. Also, it provides a faster solution.

Newton-Raphson method of the power flow equation is given in Appendix B

1.4.2 Stability Analysis

Stability analysis helps in identifying the impact of disturbances on the power system and the root cause of the problem [11]. Stability analysis is two types: steady-state analysis and transient analysis.

When a problem occurs in the system, the problem is mainly analyzed through transient stability. And, it returns the synchronous system to a stable condition. Finally, It maintains synchronism. Transient stability studies of power systems are generally performed for a minimum duration equal to the time required for oscillation. This is about 1 second or less [1]. if the system is proven to be stable during this initial swing, the disturbance will decrease throughout the next swings and the system will remain stable after that.

1.5 Organization of the paper

This thesis consists of 5 main parts. Introduction, review of literature, materials and method, result and discussion, and conclusion. Here all chapters are briefly discussed below.

1. Introduction: The introduction includes background, objectives, methodology, etc. Here discussed about the frequency and voltage stability and their importance in energy systems.

2. Review of Literature: This chapter contains the problem detection and its solving procedure. The importance of PSAF in the latest load flow analysis is discussed.

3. Materials and methods: Some mathematical equations and software are required for load and transient stability analysis. which is mainly presented in this chapter. Also, bus, generator, transformer, load, and line are used as materials here.

4.Result and discussion: The analysis and results are discussed in this chapter. All important information is taken from the graph and added to that data table. How many loads, generators, transformers, and lines are required for the analysis all are here.

5.Conculasion: This chapter contains the final conclusion of the analysis. Also, some suggestions for further research are also included here.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Frequency and voltage are the most important factor in power systems. These vary by Line Losses, Swing Bus, and Generation loss. For this reason, it needs to be properly controlled [1]. This paper discusses the common causes of voltage and frequency instability and what problems can occur when instability occurs. Also presented here are the materials and methods used for voltage and frequency instability analysis. Below are the details:

2.2 Related Research/ Works

Load Flow Analysis, line losses, mismatches, and different measures such as reactive var compensation, adding a parallel line to overloaded lines, etc. are done by using Software CYME PSAF [1]. Identification of a generator by the load flow and transient stability analysis using PSAF software whose generator governor action can greatly improve the frequency for a certain load increase or decrease and generation loss [2]. Instability occurs due to coupling with various equipment systems to a greater extent. Also, instability occurs due to sudden load increase or decrease or generation failure. For this reason, in most cases stability control is done through load shedding and automatic generation control [3] [12] The studies highlighted the balance of the power system, the relationship of the frequency grid, and the regulation of the power frequency, and also discussed large frequent disruptions in various nations and gave an overview of the stability of the energy system[11] [9]. Emergency coordinated control of generators, modified control of load tap changers (LTC), and load shedding as a last option are all taken into consideration for emergency instability control [8]. A significant portion of renewable energy sources and power electronics are rapidly replacing decades-old traditional power systems. due to equipment unbalance, which is affecting the power system stability [21]. The causes of voltage instability and classification of voltage stability in the power system has been discussed here and FACTS damping controller are used for stability enhancement [15].

Energy techniques are used to increase voltage stability in the power system, and this idea of an energy function giving a localized indicator of voltage security in a specific area of the system is created [14].

2.3 Compare and Contrast

Power flow analysis is very important for power system stability. With this system, problems can be identified very easily and problems can be eliminated in a very short time. Many software can be used to analyze energy flow. Power flow analysis by PSAF is very easy compared to other software. Which basically works as a virtual lab. When an overload occurs on the line, it is easy to know through PSAF. How many specific values should be added to another line? parallel to that line. Again ,when the frequency value decreases or increases. Then it is very easy to know with the help of PSAF as compared to other software. How much load and generation value need to increase or decrease? For the frequency return to its previous value. It's more efficient than the other software.

CHAPTER 3
MATERIALS AND METHODS

3.1 Introduction

The stability of the power system is the most important factor for energy systems. Power systems become unstable due to various reasons such as low or high power generation, sudden increase or decrease in load, disconnection of power lines, etc. Unstable power systems greatly reduce the lifespan and performance of electrical equipment. At the same time, the cost of production also increases. Basically, different types of software are used to perform stability analysis. Similarly, this stability can be analyzed by PSAF. For this reason, some data is required such as loads, generators, lines, transformers, buses, etc. This analysis provides a detailed idea of the state of the system. which later helps to analyze the system.

3.2 Methods and Materials

3.2.1 Methods

Power flow and transient stability analysis have been done by the PSAF. it's a virtual library. The simulation is done in the CYMFLOW module. It's an analytical module of PSAF dedicated to power flow analysis. Here the whole system is analyzed in two steps. The first is power flow analysis and the other is transient stability analysis. Transmission line length data (pu), line data, generator data, static load data, and transformer data are required for the simulation. For this reason, all the data should be saved in a database file. After including the necessary data then the results are generated automatically.

For the power flow and transient stability analysis, Newton Raphson Method is used because the convergence rate and solution algorithm robustness are high than the other method. This method requires less number of iterations than other methods. Also, it provides a faster solution than the other method. After that, Buses outside voltage limits, over-loaded and under-loaded lines, cables and transformers, also generators at or near reactive limits, and transformers at or near tap limits are shown in the abnormal report of the simulation result window. All abnormalities can be removed by PSAF. The limiting value of the bus voltage must be within .9 to 1.1pu. Sometimes, the

voltages of the bus are below 0.9 pu. In That case, the voltage value is increased by using capacitor banks. Most of the time, lines or cables suffer from overload. For this reason, instability occurs in the power system. Overload occurs in the line from the followings:

- Shortage of Reactive Power
- Limitation of Generated Power
- Limitation of Transmission Lines
- Limitation of Transformers
- Supply Interruptions
- Under-voltage

Overload can be eliminated by using some methods, such as: adding a bundle transmission line, adding a parallel transmission line adding a parallel generator to the main generator, adding a distribution generator near the heavy loaded and adding parallel, and adding a distribution transformer to the old transformer [1]. Abnormality report, summary report, generator active and reactive generation, bus voltage (both magnitude and angle), etc. are included in the simulation report. the report of summary contains generation, (MW and MVAR), spinning reserve (unused MW generation capacity), load and losses, and also its separate network, areas, and zones.

After that, Transient stability analysis has been done for the frequency stability curve. Then shown the several frequency curves for variation of load and generation.

3.2.1 Materials

First, CYME PASF is used for power flow and transient stability analysis. Also used for load flow analysis are buses, generators, lines, loads, and transformers. Here nine buses, three generators, and transformers, eight lines, and four loads are used. Details information are given below about the equipment.

Bus, line, load, transformer, generator are-

Table 3.1: List of the bus elements

Bus ID	Base KV	Operating KV
B1	11	11
B2	132	132
B3	11	11
B4	132	132
B5	11	11
B6	132	132
B7	132	132
B8	132	132
B9	132	132

Table 3.2: List of the line elements

From Bus	To Bus	KV Level	Loading Limit(A)	R_1 (Ω/Km)	X_1 (Ω/km)	B_1 (µ.S/km)	Length (km)
B2	B4	132	800	.4	2.4	155.50	6.52
B2	B6	132	800	.4	2.4	155.5	10
B4	B7	132	800	.4	2.4	155.5	10
B2	B4	132	800	.4	2.4	155.5	6.52
B6	B7	132	800	.4	2.4	155.5	6.52
B7	B8	132	800	.4	2.4	155.5	6.52
B8	B9	132	800	.4	2.4	155.5	6.52

Table 3.3: List of the load elements

Bus ID	P (MW)	Q(MVAR)
B2	200	30
B3	60	8
B4	200	20
B4	200	20

Table 3.4: List of the generator elements

Bus ID	Type	Voltage (KV)	Rating (MVA)	Active Generation (MW)	Max (MVAR)	Min (MVAR)
B1	Swing	11	650	200	43.59	-43.59
B3	Voltage C	11	750	500	400	-300
B5	Voltage C	11	400	200	140	-100

Table 3.5: List of the fixed-tap transformer

From Bus	To Bus	Primary KV	Secondary KV	Rating (MVA)	Z_1 (p.u.)	X_1/R_1	Standard Loading Limit (MVA)
B1	B2	11	132	400	.0150	12.5	400
B3	B4	11	132	500	.0120	12	500
B5	B6	11	132	250	.0240	12	250

CHAPTER 4
RESULTS AND DISCUSSIONS

4.1 System Description

The system has been considered by the nine Bus power system.

Table 4.1: List of system elements

System elements	Number of elements
Bus	Nine
Generator	Three
Line	Eight

The loads, generation, MVA base and kV base are –

Table 4.2: System attributes

Total generation	478.908MW
Total load	460MW
KV level	11KV
MVA Base	100MVA

4.2 Software used

We used 'Power system Analysis Framework' (PSAF) software for power flow analysis and transient analysis.

PSAF version 2.81

In transient analysis we found many plot after solving the load flow diagram. We found the time vs voltage plot and time vs frequency plot. This system is very helpful to analyze and compare different data in a single graph.

The CYME Power Engineering program is a set of applications that consist of a network editor, an analysis unit, and model libraries that can be customized by the user through which you can choose the most powerful solution.

A exceedingly intelligently graphical client interface on-screen arrange makes it simple to draw line charts and characterize the parameters of their components. Increases, cancellations, and alterations can be effectively made amid the arrange creation prepare. Information for anything on the screen can be seen (and altered) at any time with a basic tap of the mouse. As an elective to entering organize subtle elements graphically, PSAF permits information to be entered in tables. You'll select person lines of data to show on the screen as you work. A new window will open where you'll be able drag and drop the gadgets you need to see in a push on your organize. This choice permits you to part your organize into parts and see them in isolated windows.

4.3 Analysis

4.3.1 Stability analysis

In PSAF software the transient stability analysis are simulated. Internal parameter are:

Table 4.3: Transient stability system parameters

Frequency	50 HZ
Frequency Dependent Model	NO
Integration step Time	1 cycle or .02 second
Total simulation time	3000 cycle or 60 second
Base power	100 MVA
Tolerance	0.1 MVA

In transient stability analysis Global load setting parameters remain constant as default in PSAF

Table 4.4: Global load setting parameter

Zload	.500	Voltage below which load is represented by constant Z
nP	2	Exponent of voltage term in active load function
nQ	2	Exponent of voltage term in reactive load function
Pfreq	0	Corrective factor in function: Load MW vs Frequency

Qfreq	0	Corrective factor in function: Load MVAR vs Frequency

In PSAF Global Selection setting are fixed by default in PSAF.

Table 4.5: Global selection setting

Generator	Individual
Exciters	Individual
Stabilizers	Exclude all
Turbine	Exclude all
Induction Motor	Individual
Static VAR compensator	Individual
Static Load	Individual

Table 4.6: Generator exciter model parameter

ID	Gen1
Database ID	GE1
VR MAX (pu)	43.590
VR MIN (pu)	-43.590

Several events were selected for stability analysis. The event are-

1. 200 MW Load increase
2. 200 MW Load decrease
3. 200 MW Generation loss

3.4 Comparison: Comparison of Transient stability Analysis

Table 4.7: Case study chart

Case no	Event	Result curve
Case 1	200 MW load increase	1. Zone 1 (Bus 6) 2.Zone 2 (Bus 5)
Case 2	200 MW load decrease	Same as above

Case 3	200 MW generation loss	Same as above

Table 4.8: In which zone, Total generation and load

Zone	Generation	Load
Zone 1	467.619MW	260MW
Zone 2	200MW	400MW

Case-1:

Event: 200MW load increased

When 200MW load abruptly increments, the frequency falls continuously to its nominal value and after 3000 cycles, the frequency becomes 49.99 Hz.

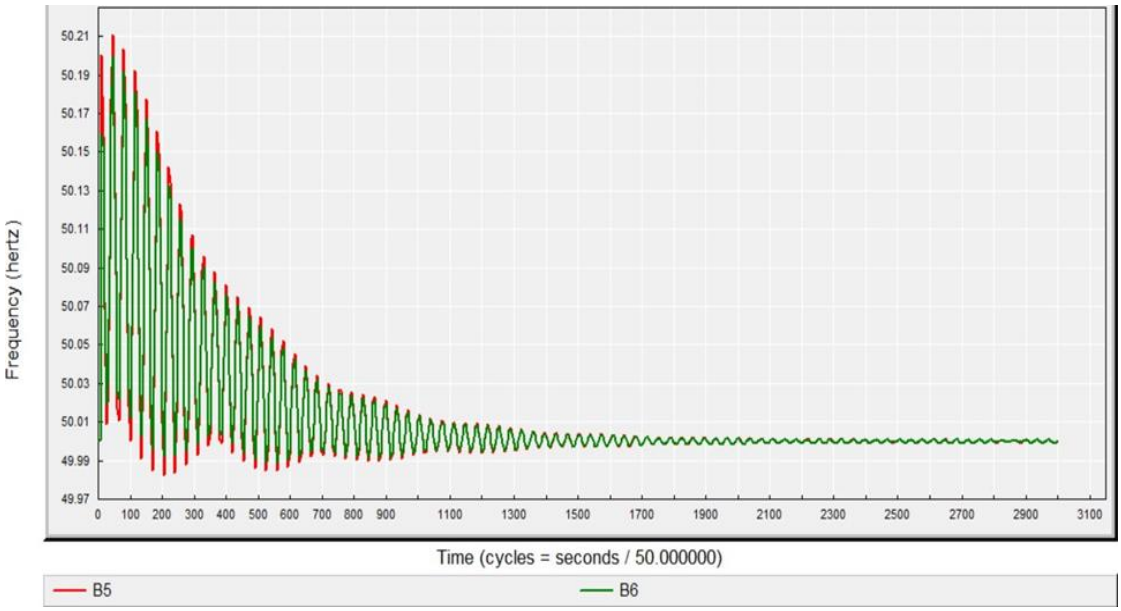

Figure 4.1: Frequency vs time when 200MW load increased

Table 4.9: 200MW load increase: frequency data from graph

Zone 1	Zone 2
49.99	49.99

Case 2:

Event: 200 MW load decrease

When 200MW load all of a sudden diminishes, the frequency rises slowly to its nominal value and after 3000 cycles, the frequency gets to be 50.46 Hz.

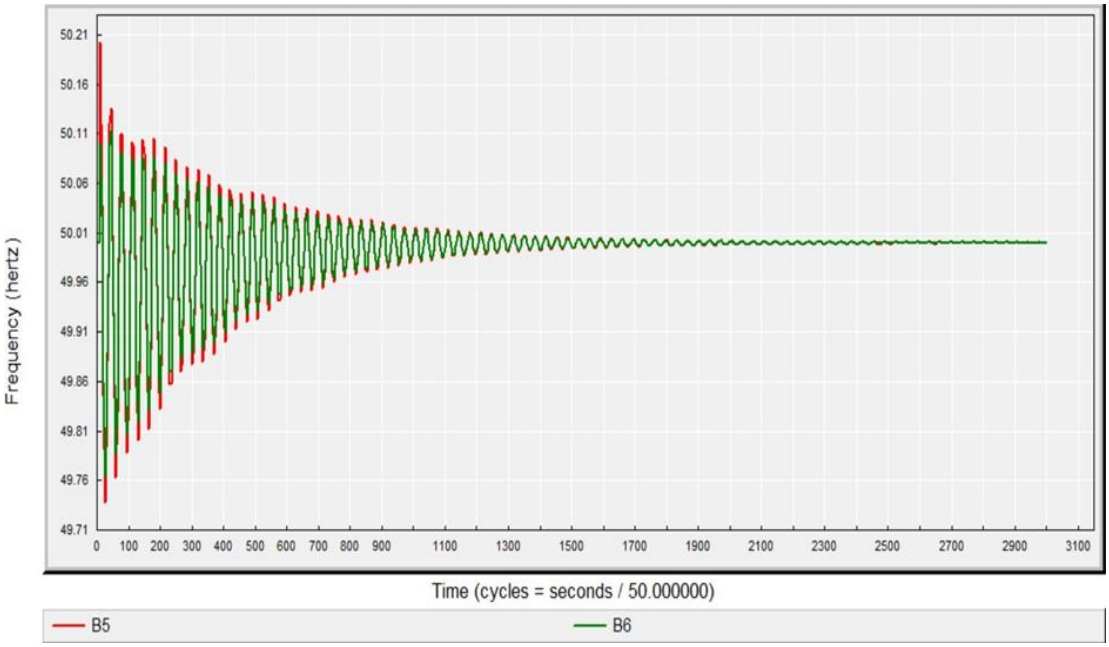

Figure 4.2: Frequency vs time when 200MW load decrease

Table 4.10: 200MW load decrease: frequency data from graph

Zone 1	Zone 2
50.01	50.01

Case 3:

Event:200MW generation loss from Zone 1

When 200MW generation reduces happens, the frequency falls slowly to its nominal value and after 3000 cycles, the frequency gets to 49.37 Hz.

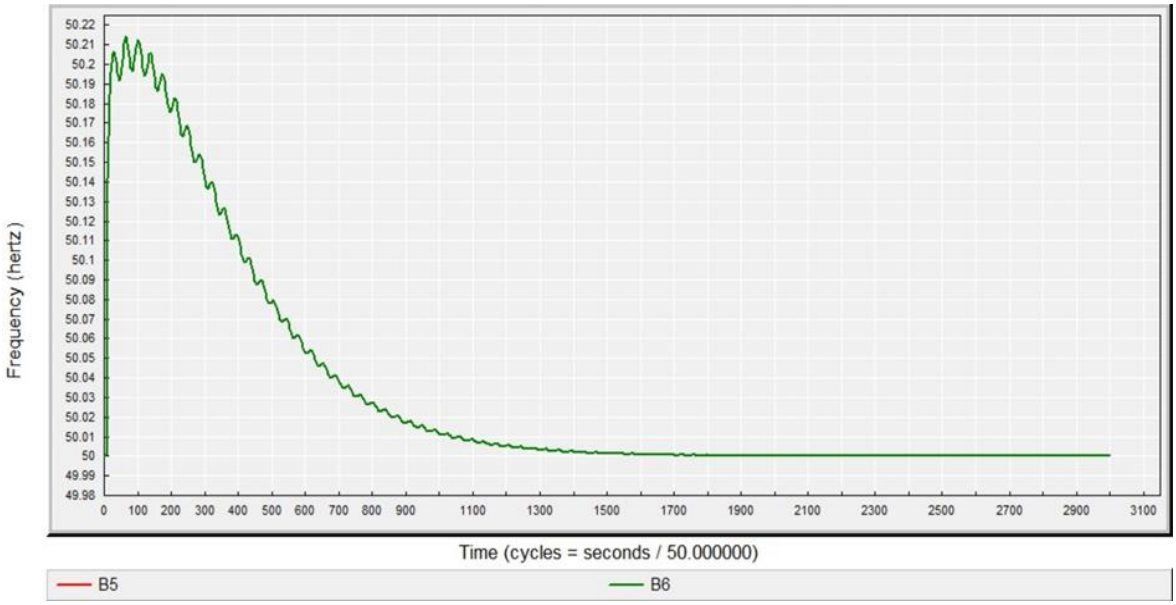

Figure 4.3: Frequency vs time when 200MW generation loss

Table 4.11: Frequency data from graph when 200MW generation loss

Zone 1	Zone 2
49.99Hz	49.99Hz

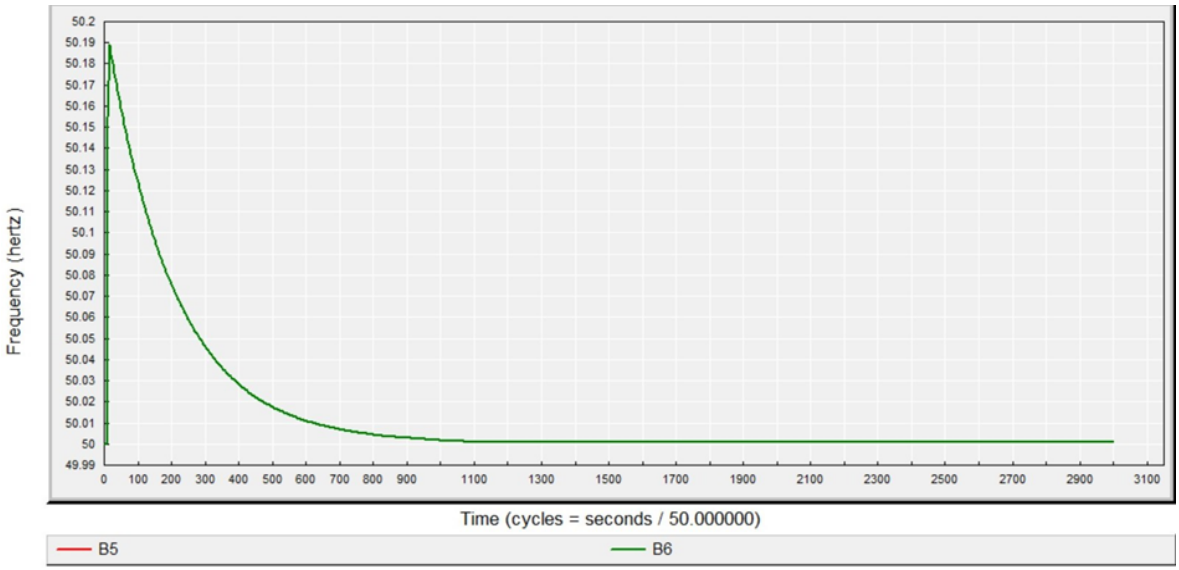

Figure 4.4: Time vs frequency when 200MW load increase and 200MW generation loss

Case 4:

When the total generation is 478.908 MW, the total load is 460 MW, and the total loss is 18.90 MW for nine buses, three generators, and eight loads. then overload occurs between lines B2 and B4. It shows in PSAF's abnormal report. After that, when a line parallel connection is made between b2 and b4. Then total generation, load, and loss are 473.57 MW, 460 MW, and 13.579 MW respectively. Finally, the value of voltage becomes a Maximum of 1.005pu and a Minimum of 0.988pu and after 3000 Cycles later it's become close to 1.00pu.

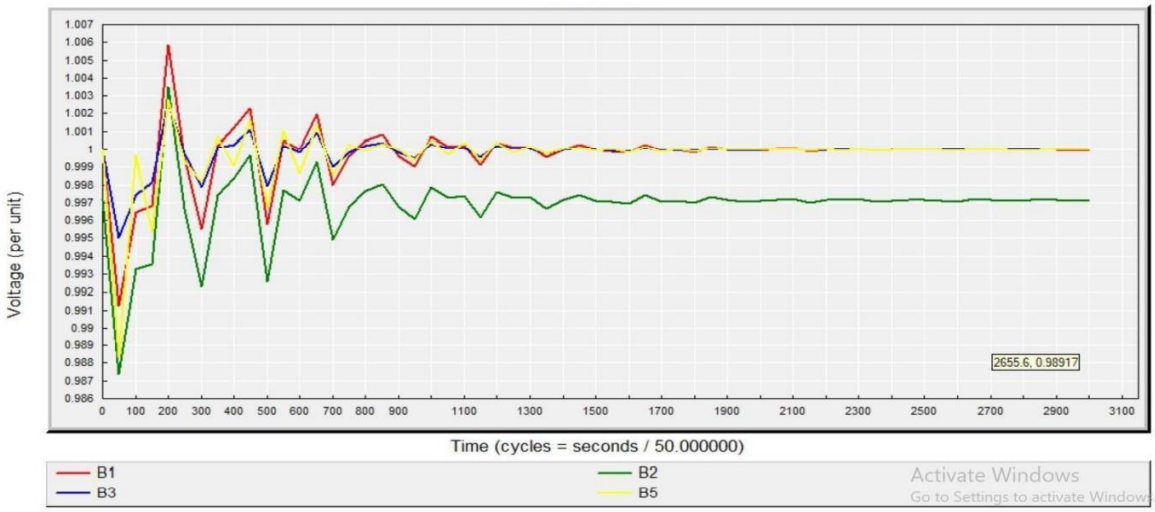

Figure: Time vs voltage curve at stable condition.

Table 4.12: Overall analysis

Event	Case-1 (load increase)	Case-2 (load decrease)	Case-3 (generation loss)
Zone 1	49.99 Hz	50.01 Hz	49.98 Hz
Zone 2	49.99 Hz	50.01 Hz	49.98 Hz

Case-1(load increase): When 200MW load abruptly increments, frequency falls continuously to its ostensible value and after 3000 cycles, recurrence gets to be 49.99 Hz.

Case-2 (load decrease): When 200MW load all of a sudden diminishes, frequency rises slowly to its ostensible value and after 3000 cycles, frequency gets to be 50.01 Hz.

Case-3 (generation loss): When 200MW generation reduce happens, frequency falls slowly to its ostensible value and after 3000 cycles, frequency gets to be 49.98 Hz.

Case-4: When the system is stable. Then the voltage value is within the specified range (.9-1.0 p.u).

4.4 Result of the analysis

1. PSAF informs the current status of related equipment such as loads, buses, generators, etc. while analyzing the power flow. Through the abnormal report, summary report, voltage, and current status of generation.
2. Loss occurs on the line due to overload. A capacitor bank is added in parallel with the line to reduce line losses.
3. System loss is much more serious than load increase.
4. Governor action is used to stabilize the power system. But currently, it is disabled I in most of the power stations.

4.2 Discussions

Frequency stability is a crucial consideration in power system operation and planning, particularly as a consequence of recent increase in load demand. There is an urgent need in each power system to consider load generation balance. Indeed on the off chance that an oscillator is set at an introductory frequency, it cannot be kept up all through. They keep on changing either in a uniform way or some of the time whimsically. The another main figure capable for deviation in frequency is varieties in control supply (working voltage connected to the load). Be that as it may, this issue can be overcome by utilizing directed control power supply.

CHAPTER 5
PROJECT MANAGEMENT

5.1 Resources and Cost Management

A software is needed to analyze power system stability. which through our supervisor, we get free through the google search engine. Through this, we can analyze the stability of the power system. No money has to be paid to download the software. It was completely free, especially for students. Those who want to do more extensive knowledge management and analysis in the future. Also, free of charge from many knowledge-based online platforms. Learned about this software and its usage. Later we collect the necessary information from our esteemed supervisor then we start to analyze. For this work, we get a lot of support from all quarters of the department including the Sir of our university. Which helped a lot in the analysis. Needless to say, this was a great example of knowledge sharing. Apparently, we have no plan for the future.

CHAPTER 6
IMPACT ASSESSMENT OF THE PROJECT

6.1 Economical, Societal and Global Impact

In order to meet the energy demand and at the same time to achieve sustainable development objectives on a global scale, the Danish government has set a long-term strategy of fossil fuel free country by the year 2050 [22]. However, the decline of conventional power generation units and a rising amount of converter interfaced components (wind turbine, HVDC, and Photovoltaic) may have negative effects on the stability of the power system.

6.2 Environmental and Ethical Issues

Producing electricity from fossil fuel which is at the heart of the climate challenge and key to the arrangement. Producing power and warm by burning fossil fills coal, oil, or gas causes a expansive chunk of the nursery gasses, such as carbon dioxide and nitrous oxide, that cover the Soil and trap the sun's warm.

6.3 Utilization of Existing Standards or Codes

Arrange to free, frayed and exposed wires have a extreme wellbeing hazard. It is the obligation of the specialist to report cases for harm or defective cable to the specialist as before long as conceivable. The most perfect way to maintain a strategic distance from hazard is to advise everybody around it and never attempt to bargain on the off chance that one isn't legitimately authorized.

6.4 Other Concerns

Electricity is very dangerous it can flow electron every conductor path when voltage occurs. So we ensure proper safety before handing electricity. Like eye and face protection, hand protection, foot protection.

CHAPTER 7
CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

Transient stability investigation includes a few mechanical properties of the machines within the process. After each unsettling influence, the machines must alter the relative points of their rotors to reach the condition of the power transfer included. We derive that, greatest control will be exchanged from sending conclusion power to accepting conclusion power. When working PSAF software, a few particular generator's exciter must be ON to settle the voltage. Voltage ought to be adjustable. Transitory steadiness alludes to the capacity of the control framework to preserve synchronism after being subjected to a serious unsettling influence, such as a brief circuit on a transmission line. Failure of transitory steadiness can lead to disastrous occasions, such as disastrous disappointment wide-spread power will be blackout.

7.2 Future Recommendations

1. load flow analysis in the PSAF is limited. if get much time then the analysis will be more.

2. This work was done within three generators. Researchers can rerun the study with more current, accurate data to produce better findings.

3. Here voltage and frequency have been dealt with. In the future, if researchers work with voltage, frequency, and phase angle. But they will get more wireless output.

REFERENCES

1. Mehnaz, N., Bhuiyan, A. I., Roy, M., & Hossain, F. (2013, January). Load flow analysis and abnormality removal of bangladesh power system using software CYME PSAF. In 2013 4th International Conference on Intelligent Systems, Modelling and Simulation (pp. 384-388). IEEE.

2. Sushil, A. (2019). Identification of Generators for Governor control In Bangladesh Power System (Doctoral dissertation, Bangladesh University of Engineering and Technology).

3. Kundur, P. S., & Malik, O. P. (2022). Power system stability and control. McGraw-Hill Education.

4. Alhelou, H. H., Hamedani-Golshan, M. E., Zamani, R., Heydarian-Forushani, E., & Siano, P. (2018). Challenges and opportunities of load frequency control in conventional, modern and future smart power systems: a comprehensive review. Energies, 11(10), 2497.

5. Fernández-Guillamón, A., Gómez-Lázaro, E., Muljadi, E., & Molina-García, Á. (2019). Power systems with high renewable energy sources: A review of inertia and frequency control strategies over time. Renewable and Sustainable Energy Reviews, 115, 109369.

6. Ma, J., Wang, S., Qiu, Y., Li, Y., Wang, Z., & Thorp, J. S. (2016). Angle stability analysis of power system with multiple operating conditions considering cascading failure. IEEE Transactions on Power Systems, 32(2), 873-882.

7. Kimbark, E. W. (1995). Power system stability (Vol. 1). John Wiley & Sons.

8. Van Cutsem, T., & Vournas, C. D. (2007, June). Emergency voltage stability controls: an overview. In 2007 IEEE Power Engineering Society General Meeting (pp. 1-10). IEEE.

9. Abdulraheem, B. S., & Gan, C. K. (2016). Power system frequency stability and control: Survey. International Journal of Applied Engineering Research, 11(8), 5688-5695.

10. Donnelly, M. K., Dagle, J. E., & Trudnowski, D. J. (1996). System Impacts of the Distributed Utility on Transmission St ability.

11. SHUKLA, M., & MEHTRE, V. V. (2022). Power System Stability and Control.

12. Hoseinzadeh, B., Da Silva, F. F., & Bak, C. L. (2014, July). Power system stability using decentralized under frequency and voltage load shedding. In 2014 IEEE PES General Meeting| Conference & Exposition (pp. 1-5). IEEE.

13. Ramírez-Betancour, R., Gutierrez-Martinez, V. J., & Fuerte-Esquivel, C. R. (2010, September). Static simulation of voltage instability considering effects of governor characteristics and voltage and frequency dependence of loads. In North American Power Symposium 2010 (pp. 1-7). IEEE.

14. Overbye, T. J., & DeMarco, C. L. (1991). Improved techniques for power system voltage stability assessment using energy methods. IEEE Transactions on Power Systems, 6(4), 1446-1452.

15. Rajpoot, S. C., Rajpoot, P. S., & Sharma, D. (2014). Power system Stability Improvement using Fact Devices. International Journal of Science Engineering and Technology research ISSN, 2319-8885.

16. Gupta, R. K., Alaywan, Z. A., Stuart, R. B., & Reece, T. A. (1990). Steady state voltage instability operations perspective. IEEE Transactions on Power Systems, 5(4), 1345-1354.

17. Yagami, M., Ishikawa, S., Ichinohe, Y., Misawa, K., & Tamura, J. (2014, September). Transient stability analysis of power system with photovoltaic systems installed. In 3rd Renewable power generation conference (RPG 2014) (pp. 1-6). IET.

18. Dobson, I., Glavitsch, H., Liu, C. C., Tamura, Y., & Vu, K. (1992). Voltage collapse in power systems. IEEE Circuits and Devices Magazine, 8(3), 40-45.

19. Morison, G.K., Gao, B. and Kundur, P., 1993. Voltage stability analysis using static and dynamic approaches. IEEE transactions on Power Systems, 8(3), pp.1159-1171.

20. Gupta, S., Tripathi, R. K., & Shukla, R. D. (2010, November). Voltage stability improvement in power systems using facts controllers: State-of-the-art review. In 2010 International Conference on Power, Control and Embedded Systems (pp. 1-8). IEEE.

21. Shair, J., Li, H., Hu, J., & Xie, X. (2021). Power system stability issues, classifications and research prospects in the context of high-penetration of renewables and power electronics. Renewable and Sustainable Energy Reviews, 145, 111111.

22. Baimel, D., Tapuchi, S., & Baimel, N. (2016, June). Smart grid communication technologies-overview, research challenges and opportunities. In 2016 International Symposium on Power Electronics, Electrical Drives, Automation and Motion (SPEEDAM) (pp. 116-120). IEEE.

APPENDIX A

Table A.1: Zone-1

Total generation	467.619 MW
Total load	260 MW
Total loss (line + transformer)	18.59 MW
Base MVA	100 MW

Table A-2: Zone-2

Total generation	200 MW
Total load	400 MW
Total loss (line + transformer)	12.78 MW
Base MVA	100 MW

APPENDIX B

The Newton-Raphson method are used for the transient and Load flow analysis.

Newton-Raphson methods are-

$$Pi = |V_i|\text{^}2\ G_{ii} + \sum_{\substack{n=1 \\ n \neq i}}^{N} |Vi\ VnVin|\ \text{COS}\ (\theta_{in} + \delta_n - \delta_i) \quad \text{.....(B.1)}$$

$$Qi = |V_i|\text{^}2\ B_{ii} + \sum_{\substack{n=1 \\ n \neq i}}^{N} |Vi\ VnVin|\ \text{SIN}\ (\theta_{in} + \delta_n - \delta_i) \quad \text{.....(B.2)}$$