

Review Paper On Power System Stability

Dr. R. P. Nikam¹, Ms. Reshma Aivale², Ms. Sakshi Bedge³, Ms. Priyaneer Bhosale⁴, Ms. Shrutika Bhosale⁵, Mr. Swapnil Bhusnur⁶, Mr. Mukund Bongale⁷, Ms. Madhura Chavan⁸, Mr. Ritesh Deshmukh⁹, Mr. Yuvraj Deshmukh¹⁰

¹Assistant professor, General sciences and engineering, AITRC, Vita

²⁻¹⁰Students, General sciences and engineering, AITRC, Vita

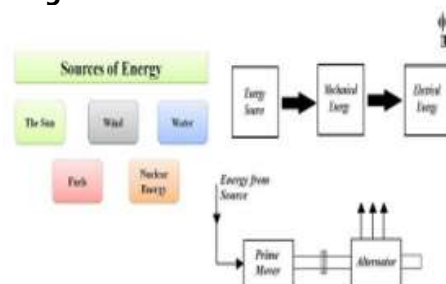
Abstract- Electric vehicles Power system stability is an important aspect of electrical engineering that ensures reliable and continuous operation of electric power systems under normal and disturbed conditions. Modern power systems face various challenges due to increasing load demand, renewable energy integration, and complex interconnected networks. Stability problems mainly include rotor angle stability, voltage stability, frequency stability, transient stability, and dynamic stability. Disturbances such as faults, sudden load changes, and generator outages can cause loss of synchronism and system collapse. Various conventional and advanced control methods are used to improve system stability and maintain system reliability. FACTS devices such as SVC, STATCOM, TCSC, and UPFC provide fast voltage and reactive power control. Renewable energy sources and converter-based technologies introduce new stability concerns due to reduced system inertia. Artificial intelligence, smart grids, PMUs, and wide-area monitoring systems are increasingly used for real-time stability assessment and control. Stability studies using mathematical modeling and simulation tools help analyze system behavior under different operating conditions. Overall, advanced control techniques and modern technologies play a vital role in enhancing the stability, efficiency, and security of future power systems.

Keywords: Power system stability, Renewable energy sources, Voltage stability, Frequency stability, AI-based approaches.

I. INTRODUCTION

This paper discusses the challenges faced by modern power systems due to the increasing integration of renewable energy sources such as solar and wind power. It explains how renewable energy affects voltage, frequency, and overall grid stability because of low inertia and fluctuating power generation. The paper also reviews different methods for stability assessment and mitigation strategies.

1. Power System Stability With High Penetration of Renewable Energy Sources





The paper classifies power system stability issues in renewable-rich grids and explains model-based, optimization-based, and AI-based methods for stability analysis. It highlights challenges such as low inertia, unpredictable renewable generation, and weak grid conditions. Different mitigation techniques and future research directions are also discussed.

The paper concludes that high renewable energy penetration significantly changes power system dynamics. Advanced control strategies, AI techniques, and optimization methods are necessary to maintain reliable and stable grid operation in future renewable-dominated power systems.

II. A REVIEW PAPER ON POWER SYSTEM STABILITY

This paper explains the importance of maintaining stability in power systems under disturbances such as faults, sudden load changes, and transmission failures. It defines power system stability and discusses the need for maintaining voltage and frequency within acceptable limits.

The paper reviews different types of power system instability including rotor angle, voltage, and frequency stability. It also explains modern FACTS devices such as SVC, STATCOM, TCSC, and UPFC used to improve system performance and reliability.

The paper concludes that FACTS devices and modern control methods play an important role in improving voltage regulation, power flow control, and overall stability of modern electrical power systems.

III. STANDARD APPROACH TO PERFORM POWER SYSTEM STABILITY STUDIES IN OIL AND GAS PLANTS

This paper focuses on transient stability studies in industrial oil and gas plants that use cogeneration and on-site generators. It explains how adding synchronous generators increases system complexity and stability concerns.

The paper discusses procedures and standards for conducting transient stability studies in industrial plants. It explains modeling techniques, generator dynamics, protection systems, and the importance of maintaining synchronism during disturbances.

The paper concludes that accurate system modeling and transient stability studies are essential for ensuring safe and reliable operation of industrial power systems with on-site generation.

IV. A REVIEW ON POWER SYSTEM STABILITY AND APPLICATIONS OF FACT DEVICES

The paper introduces power system stability as a major concern in electrical networks and explains how instability affects voltage and frequency. It also discusses the evolution of modern FACTS devices for system control.

The paper reviews various stability classifications and explains the applications of FACTS devices such as STATCOM, TCSC, and SVC in improving power system performance and damping oscillations. The study concludes that advanced FACTS devices provide faster and more efficient control compared to conventional compensation methods, thereby improving system stability and reliability

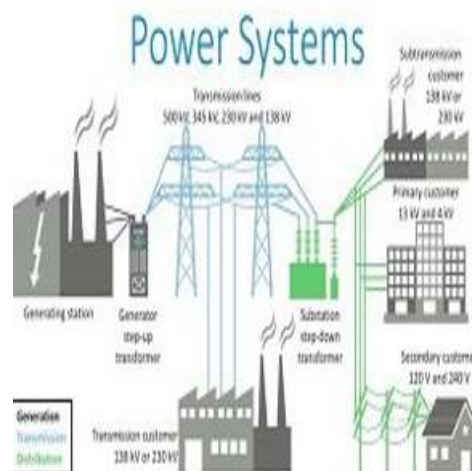
V. STABILITY STUDY OF POWER SYSTEM

This paper explains the theory and importance of power system stability and studies the effects of disturbances on interconnected power systems using MATLAB simulation

The paper studies steady-state, transient, and dynamic stability using a two-machine three-bus power system model. Different operating conditions such as fault position and mechanical power are analyzed to evaluate system robustness.

The paper concludes that transient stability analysis is essential for understanding system behavior during disturbances and for designing stable and reliable power systems.

VI. POWER SYSTEM STABILITY



This document introduces the concept of power system stability and explains how systems respond to disturbances. It mainly focuses on rotor angle stability and synchronous machine dynamics.

The document explains classifications of stability and derives the swing equation used in transient stability analysis. It also discusses synchronous machine dynamics and multi-machine systems. The document concludes that rotor angle stability analysis and swing equations are fundamental tools for understanding and improving power system stability.

VII. DEFINITION AND CLASSIFICATION OF POWER SYSTEM STABILITY – REVISITED & EXTENDED

This IEEE paper revisits traditional power system stability definitions considering modern converter-based renewable energy systems and power electronic devices.

The paper extends classical stability classifications to include converter-interfaced generation technologies such as solar PV, wind turbines, HVDC, and FACTS devices. It discusses fast electromagnetic dynamics and new stability concerns in modern grids.

The paper concludes that future power systems require updated stability definitions and advanced analysis methods because converter-based technologies significantly change system dynamics.

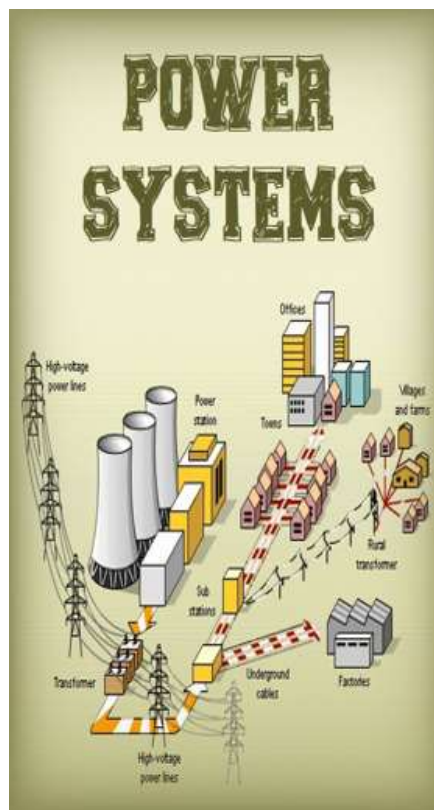
VIII. ADVANCED REVIEW ON POWER SYSTEM STABILITY AND CONTROL

This review paper discusses modern power system stability and control techniques in the presence of renewable energy, smart grids, and digital technologies.

The paper explains different types of stability and discusses conventional and modern control methods including AI, PMUs, WAMS, HVDC systems, and smart grid technologies for enhancing reliability.

The paper concludes that AI-based control, smart grids, and advanced monitoring systems will play a major role in maintaining stability in future intelligent power systems.

IX. POWER SYSTEM STABILITY AND CONTROL



This handbook provides comprehensive knowledge about power system stability, protection, dynamics, operation, and control in electrical engineering.

The book covers power system protection, transient stability, oscillation analysis, voltage stability, dynamic security assessment, and power system control techniques used in modern electrical networks.

X. CONCLUSION

Power system stability is one of the most important requirements for reliable and secure operation of electrical power systems.

Modern interconnected power networks are becoming more complex due to increasing electricity demand and renewable energy integration.

Disturbances such as faults, sudden load changes, transmission failures, and generator outages can seriously affect system performance.



Maintaining synchronism among generators is essential to prevent system collapse and large-scale blackouts.

Power system stability mainly includes rotor angle stability, voltage stability, frequency stability, transient stability, and dynamic stability.

Each type of stability plays a significant role in maintaining continuous and efficient power supply. Traditional control techniques such as AVR, PSS, and governor control improve system performance under varying operating conditions.

Advanced technologies like FACTS devices provide fast and effective control of voltage, reactive power, and power flow.

Devices such as SVC, STATCOM, TCSC, and UPFC greatly enhance transmission capability and stability margins.

HVDC transmission systems also improve controllability and reduce transmission losses in long-distance power transfer.

Renewable energy sources such as solar and wind power introduce new challenges because of their intermittent nature and low inertia.

REFERENCES

1. Power System Stability and Control, Edited by Leonard L. Grigsby, CRC Press, 2007.
2. Power System Stability and Control, Prabha Kundur, McGraw-Hill Education, 1994.
3. IEEE Task Force Report, Definition and Classification of Power System Stability – Revisited & Extended, IEEE Transactions on Power Systems, 2020.
4. Power System Stability studies from International Journal of Energy and Power Engineering, Vol. 4, No. 2, 2015.
5. Priyank Srivastava and Rashmi Pardhi, A Review on Power System Stability and Applications of FACT Devices, International Journal of Engineering Research and Applications (IJERA), 2013.
6. Mohammed Mynuddin, K. M. Roknuzzaman, Prodip Biswas, and Mohammad Tanjimuddin, Stability Study of Power System, International Journal of Energy and Power Engineering, 2015.
7. JJ Dai and Richard Dourian, Standard Approach to Perform Power System Stability Studies in Oil and Gas Plants, PCIC Europe Conference Paper, 2019.
8. Flexible AC Transmission Systems related research papers and IEEE publications on voltage and transient stability improvement.
9. Research articles on renewable energy integration, smart grids, HVDC systems, and artificial intelligence applications in modern power systems.