F.NO.COE/Ph.D./(Notification)/579/2025 **Notification Date: 30/05/2025**

Student's Name: Rajesh Kumar

Supervisor's Name: Prof. Haroon Ashfaq

Supervisor's Name: Dr. Rajveer Singh

Name of the Department: Department of Electrical Engineering

Name of the topic: Performance Improvement of a Distribution System Integrated with WECS

Findings:

Key Words: Distribution system, Voltage profile improvement, Power quality, Optimal location, DSTATCOM, Multiple Complex Coefficient Filter;

Wind energy has become one of the finest choices amongst the renewable sources because it has the ability to contribute substantially to contemporary power grids. The developments in power electronics, microcontrollers, and digital signal processors have pushed the progression of wind energy conversion systems (WECS). Even though wind power is intermittent and seasonal, deploying wind turbines in wind-swept areas over large geographic locations ensures steady power output.

The integration of WECS into power grids has grown exponentially. With centralized power supply yielding to decentralized renewable energy sources, the distribution network must adjust to the shift. But the integration of WECS is not without technical challenges of voltage stability, power quality, and system reliability. The inherent turbulence of wind makes the power output fluctuate, resulting in voltage oscillations and frequency excursions. Traditional grids, designed to operate with predictable flows of power, fail to accommodate such situations.

To harness the full potential of Distributed Generators (DGs) like wind turbines, it is important to take their placement and capacity into consideration. Proper integration can improve voltage profiles, reduce system losses, and improve reliability. Thus, in this context, Enhanced Dung Beetle Optimization (EDBO) has been employed to find the optimal positions and capacities of wind-based DGs in the IEEE-13 and IEEE-34 test systems, and comparisons have been made with approaches established in the literature available.

High power quality has become more critical with the higher complexity of the electrical load and higher use of renewable sources of energy. Distribution Static Compensators (DSTATCOMs) are advanced technologies used to control reactive power, thereby reducing voltage fluctuations, improving the power factor, and compensating harmonic distortion. With the incorporation of harmonic filters, DSTATCOMs reduce total harmonic distortion (THD) by a significant amount, especially in industrial environments with non-linear loads. Additionally, in this study, Prairie Dog Optimization (PDO) is used to improve the performance of DSTATCOMs, exhibiting faster responsiveness and better efficiency compared to conventional algorithms.