Name : **Mohammad Saood**
Supervisor : **Dr. Haroon Ashfaq** (Department of Electrical Engineering, JMI)
Department : Department of Electrical Engineering, Jamia Millia Islamia, New Delhi-110025
Thesis Title : **Modeling and Simulation of a Standalone Hybrid Wind/Micro-Hydro Power System**

ABSTRACT

Despite various benefits of the renewable energy, they are difficult to manage. The main drawback is associated with the variability of these sources. The generated power from these sources usually fluctuates rapidly, which impose difficulties in both operation and control.

Multi-source hybrid renewable energy sources to some extent overcome the intermittency, uncertainty, and low availability of single-source renewable energy systems, making the power supply more reliable. So, two or more systems are used in the form of hybrid system such that they complement each other. One of the main characteristics of wind power is the inherent variability and unpredictability of the generation source, even in the short-term. Micro-hydro and wind power are complementary because sunny days generally have very low wind while cloudy days and night times are more likely to have strong wind. Therefore, hybrid Wind/Micro-hydro power systems have higher availability and reliability than systems based on individual Micro-hydro or wind sources.

The primary energy sources for the system are micro-hydro and wind generators, while battery helps to regulate power in the system by providing deficit power or absorbing surplus power, and hence supports in maintaining stable voltage and frequency at output terminals of the developed system.

Vertical axis wind turbines (VAWTs) are appealing option being most suitable for small scale applications. They are considered for placement at rooftops and residential locations as they have many advantages such as it can capture wind from any direction and do not need any yaw mechanism for orientation of turbine towards the wind. The proposed sensorless control method regulates rectifier dc output voltage using PI controller to control generator speed for MPPT tracking at low and medium wind velocities. But at wind velocities higher than rated value, turbine is stalled at

rated power and compensation for stability is done due to instability of normal MPPT control during this mode.

In PMSG based variable speed micro-hydro power systems, output of PMSG is supplied to an uncontrolled bridge rectifier supplying dc-dc boost chopper, which is then controlled to regulate the speed of generator to track maximum power at all water discharge rates. The method does not require the knowledge of hydro turbine's maximum power curve or the information of water discharge rate or head. A variable step MPPT algorithm is proposed which is controlling duty ratio of the dc-dc converter according to the result of the comparison of successive generator output power measurements.

The Energy Management and Power Regulation System (EMPRS) for the developed hybrid power system is a system controller and manager which controls the flow of power and manages different operating modes in the whole system depending on the battery state of charge (SOC) and the load.

Further, to improve the output power quality of H-bridge inverter, the issues of harmonics and dc current injection are explored. Selective harmonic elimination is done as there is a limited number of harmonics with developed maximum current control method of inverter control. Sources of dc current injection are discussed, and then measurement and control circuits are proposed for inverter to eliminate dc current injection. These methods improve the output power quality of the developed system as per the international standards.

Finally, to improve overall performance of the system, load optimization is done. To improve the overall performance of the developed hybrid system, out of the three types of major loads, motor load is optimised to run at minimum VA, so that system resources can be utilised effectively and hence reducing the overall cost of the system.

This developed hybrid system is expected to be used private residential applications as it requires simple controllers and circuits that are easy to implement and lower the overall size and cost of the system.