# UNIVERSITI TEKNOLOGI MARA

# ANT LION OPTIMIZER FOR SOLVING UNIT COMMITMENT WITH SOLAR PHOTOVOLTAIC INTEGRATION

**IZNI NADHIRAH BINTI SAM'ON**

Thesis submitted in fulfillment
of the requirements for the degree of
**Master of Science**
**(Electrical Engineering)**

**Faculty of Electrical Engineering**

**February 2020**

# AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

| | | |
|---|---|---|
| Name of Student | : | Izni Nadhirah binti Sam'on |
| Student I.D. No. | : | 2015641156 |
| Programme | : | EE750 |
| Faculty | : | Electrical Engineering |
| Thesis Title | : | Ant Lion Optimizer for Solving Unit Commitment with Solar Photovoltaic Integration |
| Signature of Student | : | …….. |
| Date | : | February 2020 |

# ABSTRACT

The existing power grid is incapable of providing sufficient electricity due to the rapid growing of power demand. Demand during peak load hours is generally more than the supply from power grids. Nowadays, most of the power plants are using fossil fuels for electricity generation. The non-renewable resources of fossil fuels cannot be replenished and eventually the source will run out. Existing fossil fuels cannot supply the power demand. It is important to use alternative source of renewable energy for electricity generation. Effective management of power generation is important when deals with integration of renewable energy into existing power grid. This research is based on solving unit commitment problem with and without the integration of solar photovoltaic (PV). Data for IEEE 39-bus with 10-unit generators are used with the consideration of system constraints in unit commitment such as power balance, system reserve requirement, generation limit of generators, and minimum up and down time constraints. A new technique of Ant Lion Optimizer (ALO) is proposed to solve the unit commitment problem. ALO is inspired based on hunting behaviour of ant lion. There are five main steps, which include random walk of ants, trapping of ants in antlions' trip, building trap, sliding of ants towards antlion, catching prey and rebuilding the pit. The proposed ALO algorithm is able to identify the global optimum solution since the intensity of ants' movement is adaptively decreased as the number of iterations increase. In addition, the exploration of search space is guaranteed within the limitation of set-up boundaries. This behaviour will enhance the optimization towards the optimal and global solution. The performance of the proposed algorithm is compared with the performance of Dynamic Programming (DP) technique in terms of generation scheduling, total operating cost (TOC) and computation time. Both techniques are implemented to solve optimal UC with and without PV integration in grid system. From the results obtained, ALO provides better generation scheduling with lower TOC, as compared to DP technique. The cost saving per year performed by ALO technique as compared to DP is $236,520 in grid system without PV integration. As for UC with PV integration, the uncertainties are considered due to the irregular nature of PV output. The uncertainties are categorized into three groups which are the lowest, average and highest penetration of PV. Penetration of PV in grid system contributes about $6,612,705 of cost saving per year. Based on the results, ALO provides better solution as compared to DP in terms of providing better generation scheduling, and significant reduction of TOC and with lower computation time.

# ACKNOWLEDGEMENT

Praise to Allah, The All Mighty for the blessing and mercy given onto me to complete this project.

I would like to take this opportunity to express my sincere gratitude and appreciation to my supervisor, Dr. Zuhaila Mat Yasin for her continuous guidance and assistance towards the accomplishment of this research work and in the preparation of the thesis. I am also indebted to Faculty of Electrical Engineering, Universiti Teknologi MARA (UiTM) for allowing me to fully utilise the necessary facilities during my studies. I would also like to record my gratitude to my co-supervisor, Professor Dr. Zuhaina Zakaria for her support and encouragement to complete this research.

Special appreciation, love and gratitude to my parents, Sam'on Bin Hj. Hassan and Harlina Binti Abu Saad, my husband Mohd Fauzi Bin Che Soh for their support and being my source of inspiration.

Izni Nadhirah Binti Sam'on

Faculty of Electrical Engineering

Universiti Teknologi MARA (UiTM)

# TABLE OF CONTENTS