College: Engineering **Student's Name:** Bassim Naeem Abdul Sada
Dept.: Electrical Engineering **Supervisor's Name:** Assist. Prof. Dr. Ramzy S. Ali / Assist. Prof. Dr. Khearia A. Mohammad
Certificate: Master **Specialization:** Power and Machines

Title:
Microcontroller Based Cathodic Protection System

Abstract:

The present study deals with the theoretical and experimental studies for the cathodic protection (CP) system. The present work may divide into two parts: The first part deals with the identification and the control of an impressed current cathodic protection system (ICCP). The installation of a prototype ICCP for submerged carbon steel bare pipe segment (new and old one) which is immersed in the saltwater solution are designed and implemented. The change of several variables affecting submerged metallic structure in natural water, such as conductivity, temperature, and aeration flow rate on the cathodic protection current are studied. The experimental results show that the cathodic protection current increase for increasing any variables of the saltwater solution. And the cathodic protection current required for the old pipe greater than the new pipe segment for protection. The data is obtaining from experimental ICCP system model applied on the same prototype, used to build the identification model of the ICCP system by using an Adaptive Neuro-Fuzzy Inference System (ANFIS) technique using MATLAB R2015a program to predict cathodic protection current. An ANFIS has proven to be efficient in identification model of ICCP system, and easy with MatLab program to obtained equivalent model.

Then the ANFIS was used to identify the system and obtain a model to build a controller for the cathodic protection current of CP system to set pipeline potential at desired level. Here we used two control techniques, PID, and Fuzzy controllers. Based on the MatLab Simulink results, a conclusion had been made that both of the control methods were capable of controlling the CP system. But, it was observed that the PID controller required very fine tuning of its parameters, but fuzzy controller gave response better than the conventional one and took less time to track reference voltage than PID controller. In the second part, the design and the implementation of the practical controller and monitoring for the same prototype ICCP system. The proposed design consists of two stages, the power, and control. The power stage represents the design and building the DC/DC buck converter driven impressed current of CP system. While, the control stage has been implemented using simple control, and PID controller. The Arduino is used as a microcontroller to regulate the output voltage of the buck converter and to monitor the CP system via a data acquisition such as pipe's voltage by the reference electrode, output voltage and current of the buck converter. The reference electrode voltage has been used as a closed-loop feedback to determine the error between the desired value and the actual

value by changing the reference electrodes, and the electrolyte conditions of the saltwater solution. From the experimental results showed that the simple control and the PID controller are easily implemented practically for ICCP system. But observed that the time of the return system to the protection range is large, and oscillate around the desired values for simple controller, while the PID controller has the best behavior at different coefficient values with respect to the first one. Therefore, the PID controller has a good response, robust and simple for the ICCP system.