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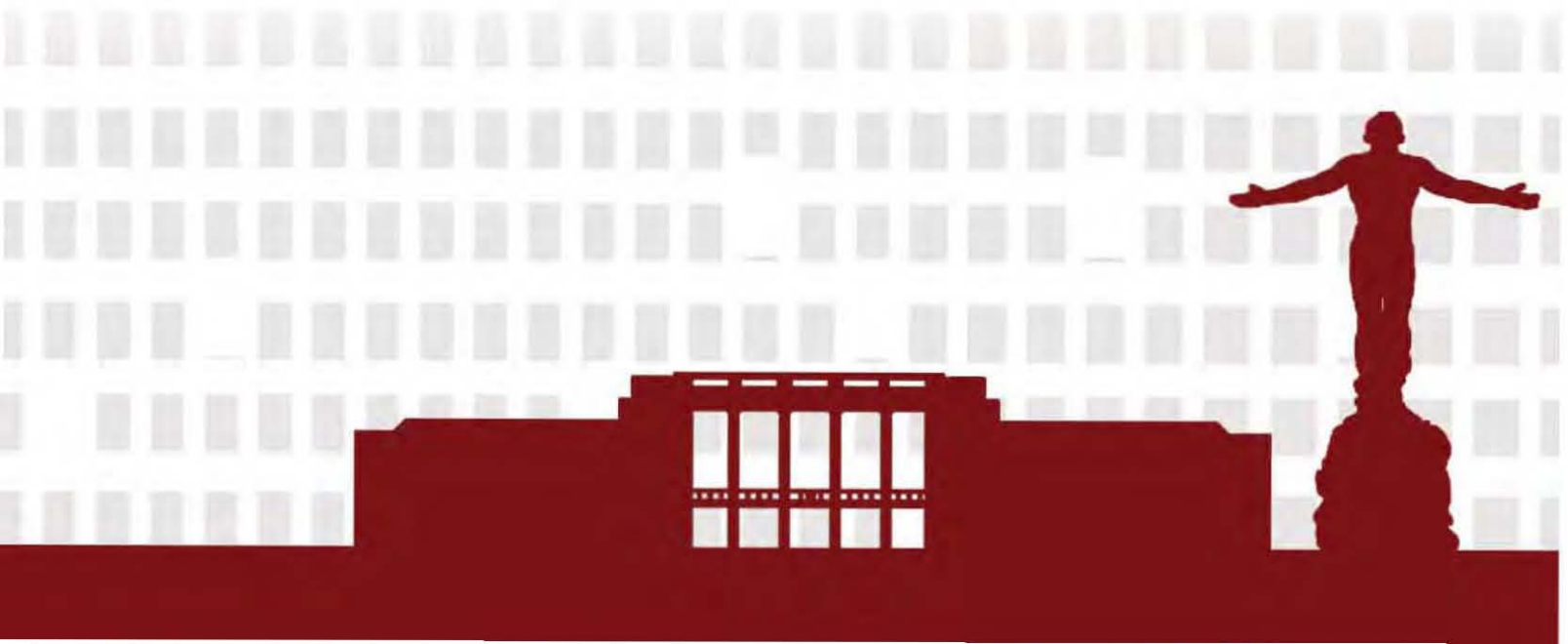

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PARAMETER EXTRACTION OF OPTOELECTRONIC pH SENSOR BASED ON THE HUE ABSORBANCE OF A pH TEST STRIP

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ABSTRACT

Optical pH measurement commonly uses a strip of paper with embedded indicator. A pH test strip which has four (4) test pads changes its color when it is dipped in a sample solution. A Bogen universal indicator solution is used in one of the study to cause a color change in a sample depending on the pH of the sample. It is combined with a white light source and CMOS optical sensor chip to measure pH with color change as an input. The output voltage of the CMOS photodetector will give the equivalent pH value. This sensor can determine the pH of the sample from pH 1 to 9 in real-time. Aside from using Bogen universal indicator, paper-based indicator like test strip has also been introduced that shows color change when it is dipped in the solution. To determine the pH value of the sample, the color change of the test strip is compared to a color chart. A schematic diagram of the absorption-measuring optical module is developed. This is composed of tri-chromatic LED, photodiodes and polymer light guide. This device is able to detect the color change by measuring the optical absorbance of the urine test strip. The color change is analyzed to determine the amount of glucose, protein and red blood cells.

The purpose of this study is to extract the parameter of an optoelectronic pH sensor based on the hue absorbance of the pH test strip and be implemented on Simulation Program with Integrated Circuit Emphasis (SPICE). Through experiments using a devised sensor module, highest linearity is obtained when the I_{LED} is 20 mA. The sensitivity of the device at pad 1 is 0.4217 mV/pH with a correlation coefficient of 0.8177, pad 2 is 0.3667 V/pH with a correlation coefficient of 0.9597, pad 3 is 0.2659 V/pH with a correlation coefficient of 0.0.9923, and pad 4 is 0.0347 V/pH with a correlation coefficient of 0.9948. It outputs the RGB Hue levels (in voltage) of the pH test strip.

Optoelectric characteristics of the pH sensor are described by the result acquired in the experiments on parameter extraction. The transconductance of the device is derived based on the phototransistor current and pH-dependent voltage. The extracted parameters used on the equivalent circuit of the optoelectronic pH sensor is simulated on SPICE. The percent error between the responses on experimental and simulation of the test pads 1, 2, 3 and 4 are 10.28%, 0.01%, 0.34% and 0.86% respectively. Based on these results, an optoelectronic pH sensor model is developed.

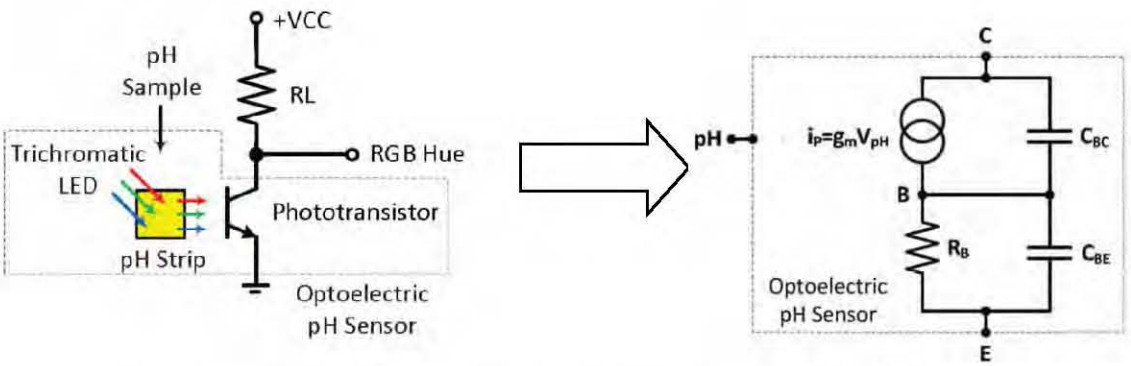

Figure 1. Optoelectronic pH sensor to equivalent SPICE Model

Keywords: absorbance, optoelectronic, pH sensor, SPICE.

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