Python Project

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Probability and Statistics for EECE

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# Introduction & Objective

Probability and statistics are fundamental tools for Electrical and Computer Engineers, used in analyzing data, understanding variability, designing systems, and making decisions under uncertainty. This project provided an opportunity to apply the concepts and software tools learned to a problem or dataset of interest within the ECE domain.

# Project Scope & Topic Selection

Our chosen topic is to model the reliability and accuracy of components like resistors, capacitors, and transistors through confidence intervals. By taking a set of samples from the available components in inventory, we can calculate confidence intervals with varying alpha values and degrees of freedom.

The random variables we will be working with are measurements of the different components. For example, the resistance of resistors in ohms, the capacitance of capacitors in farads, and the transconductance of transistors in siemens are all random variables which we will be able to create confidence intervals for using our Python program.

We will obtain our data by taking measurements for different values of components which we will borrow from the components inventory. We will use the corresponding tools, i.e. multimeters and oscilloscopes, to sample the relevant data.

We aim to quantify the deviation in our components from their intended values using confidence intervals. Using graphical representations and the matplotlib library, we will generate interpretable and visual graphics for the data and confidence intervals.

# Core Project Tasks

We measured 25 resistors advertised at 10 Ohms each; 20 capacitors advertised as 47 nFarads each, and 15 2N3904 BJTS. For the transistors, we used a digital multimeter and a DC Power Supply to measure the IC current with a thermal voltage of 26mV.

Transconductance = Collector current / thermal voltage

## Data:

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Number (n)** | **Sample Mean** | **Standard Deviation** |
| **Transistors** | 15 | 0.1941 | 0.0106 |
| **Resistors** | 25 | 9.9729 | 0.0576 |
| **Capacitors** | 20 | 49.465 | 0.4591 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Critical Value** | | | **Margin of Error** | | |
|  | C90 | C95 | C99 | C90 | C95 | C99 |
| **Transistors** | 1.761 | 2.145 | 2.977 | 0.0049 | 0.0059 | 0.0082 |
| **Resistors** | 1.706 | 2.056 | 2.779 | 0.0189 | 0.0228 | 0.0308 |
| **Capacitors** | 1.729 | 2.093 | 2.861 | 0.1775 | 0.2149 | 0.2937 |

### Graphs

**BJT:**

A diagram of a normal distribution

AI-generated content may be incorrect.

**Capacitor:**

A diagram of a normal distribution

AI-generated content may be incorrect.

**Resistor:**

A diagram of a normal distribution

AI-generated content may be incorrect.

# Summary