# EE 104 Lab 5 Documentation

The objective of this lab was to use differential toolkits from numpy and scipy to solve and model real-world situations. The required dependencies and versions are outline in the Pipfile located in the root of this repository.

## Sections

### Head Injury Criterion (HIC)

The HIC index is calculated for a specified Mercedes crash test. The crash test data is approximated using a trival model and the HIC curves are shown.

### Electron Force

This portion of the lab calculates the amount of work done to move two electrons up to 10 picometers away from each other.

### RLC

The RLC script calculates the current of the circuit given arbitrary RLC components. The output of this script shows the current over time.

### ERU and ICU Modeling

A hospital’s ERU and ICU are modeling using the physical system of cascaded fluid tanks. The output of this script shows the fill rate of the two units throughout the last ~2 years of covid. The fill rate is a function of the number of people being admitted for covid, the number of seats in the ERU, the number of respirators in the ICU, and the number of nurses available to treat patients.

## Documentation

### HIC

The second code block shows the generated model in respect to the actual data of the Mercedes crash test. The third code block uses sympy to model the following equation to calculate the HIC curve as a function of d:

Diagram

Description automatically generated

The different curves are then plotted in the following blocks with the maximum value representing the HIC for this test.

### Electron Force

This is a trivial script that solves for the equation . The distances a, and b can be changed to the user’s liking.

### RLC

The values of RLC can be modified as well as the differential equation in the second code block.

### ERU and ICU

This script has multiple parts that can be varied. The general outline of this function is as follows:

1. The first part of this script uses CDC data and imports the total number of covid cases over time as a pandas dataframe. This data is processed and used to generate the Qin for the model.
   1. Qin can be used as the direct numerical derivation of the total covid cases overtime
   2. Qin can also be the symbolic derivation of the curve fit of the total covid cases over time. This portion of the code is unused as the generic curvefit yields a very linear model. Can probably be improved on if a sigmoid model is used rather than a logarithmic approximation.
2. The script is processed in the final block of code. Things to note are that the seats, respirators and nurses can be varied by the user, using the constants at the top.
3. The qout1 and qout2 are multiplied by a constant that represents the number of days to leave the specified unit. (3 days for ERU and 14 days for ICU). The min function is used to specify the maximum number of patients that can be discharged in respect to the number of nurses available. In this cases the maximum number of patients that can be discharged from the ERU is equal to the number of nurses\*5, while the maximum number of patients that can be discharged from the ICU is directly equal to the number of nurses available.
4. If the ICU overfills (h2> 1) then those patients are moved to the ERU. If the ERU is overfilled then the patients are turned away
5. The final portion of the code block plots the response of the system to qin