import numpy as np  
from numpy import linalg as LA  
import matplotlib.pyplot as plt  
  
data\_read = np.genfromtxt('testLab1Var7.csv',delimiter=',')  
  
time = data\_read[:,0]  
time = time[:,np.newaxis]  
current = data\_read[:,1]  
current = current[:,np.newaxis]  
voltage = data\_read[:,2]  
voltage = voltage[:,np.newaxis]  
  
fig,(ay1,ay2) = plt.subplots(2,1,sharex=True)  
T\_per = 0.1  
ay1.plot(time[time<2\*T\_per],voltage[time<2\*T\_per])  
ay1.grid()  
ay1.set\_xlabel('time, s')  
ay1.set\_ylabel('voltage, V')  
ay2.plot(time[time<2\*T\_per],current[time<2\*T\_per])  
ay2.grid()  
ay2.set\_xlabel('time, s')  
ay2.set\_ylabel('current, A')  
plt.show()  
fig.savefig('Recieved data(part)')  
  
X = np.concatenate([voltage[0:len(voltage)-2],current[0:len(current)-2]], axis = 1)  
Y = current[1:len(current)-1]  
K = np.dot(np.dot(LA.inv(np.dot(X.T,X)),X.T),Y)  
  
Td = 0.001  
R = 1 / K[0] \* (1 - K[1])  
T = -Td / np.log(K[1])  
L = T\*R  
  
current\_est = X.dot(K)  
  
fig, ax = plt.subplots(1, 1)  
plt.plot(time[time<T\_per],current[time<T\_per])  
plt.plot(time[time<T\_per],current\_est[time[0:len(current)-2]<T\_per])  
ax.grid()  
ax.set\_xlabel('time, s')  
ax.set\_ylabel('current, A')  
plt.show()  
fig.savefig('Compared data(part)')  
  
R\_est = []  
L\_est = []  
  
n = 1000  
for i in range(0, n-1, 1):  
 ind = (time>=T\_per\*i) & (time <= T\_per\*(i+1))  
 new\_current = current[ind]  
 new\_current = new\_current[:, np.newaxis]  
 new\_voltage = voltage[ind]  
 new\_voltage = new\_voltage[:, np.newaxis]  
  
 X = np.concatenate([new\_voltage[1:len(new\_voltage) - 1], new\_current[0:len(new\_current) - 2]], axis=1)  
 Y = current[1:len(new\_current) - 1]  
 K = np.dot(np.dot(LA.inv(np.dot(X.T, X)), X.T), Y)  
  
 if K[1] > 0:  
 R = 1/K[0]\*(1-K[1])  
 T = -Td / np.log(K[1])  
 R\_est.append(R)  
 L\_est.append(T\*R)  
  
R\_est = np.array(R\_est)  
L\_est = np.array(L\_est)  
  
print('Mean value of R: ',np.mean(R\_est),' Ohm')  
print('Standart deviation of R: ',np.std(R\_est))  
print('Mean value of L = ',np.mean(L\_est),' Hn')  
print('Standart deviation of R: ',np.std(L\_est))