EE230: Lab 8 (Offline)
Logarithmic Amplifier

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1 Analysis of the IN4148 diode data

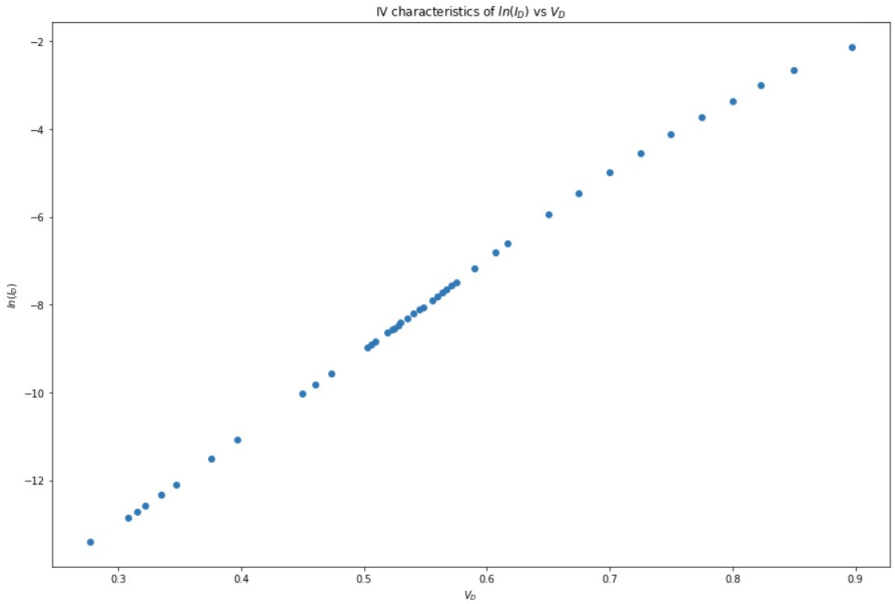

Fig 1: Scatter plot for I-V Characteristics of the given IN4148 diode data

We notice that the curve is nearly linear for all the voltages less than 0.65V.

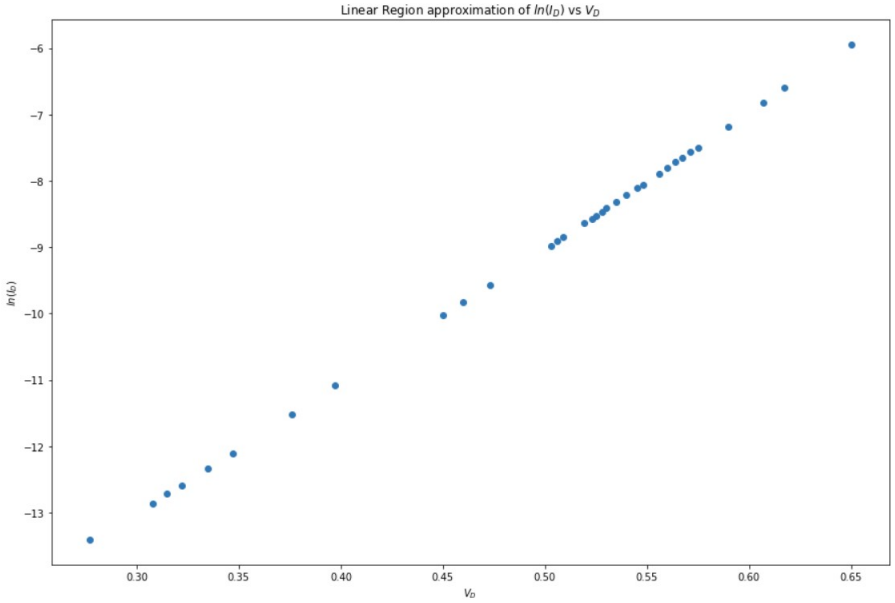

Fig 2: Linear region of the given IN4148 diode data

A Linear Regression model of the form $y = mx + c$ was fitted and the mean square error $\sum_{i=1}^{n}(y_i - (mx_i + c))^2$ was minimised to get the best possible values of $(m, c) = (20.114, -19.0657)$

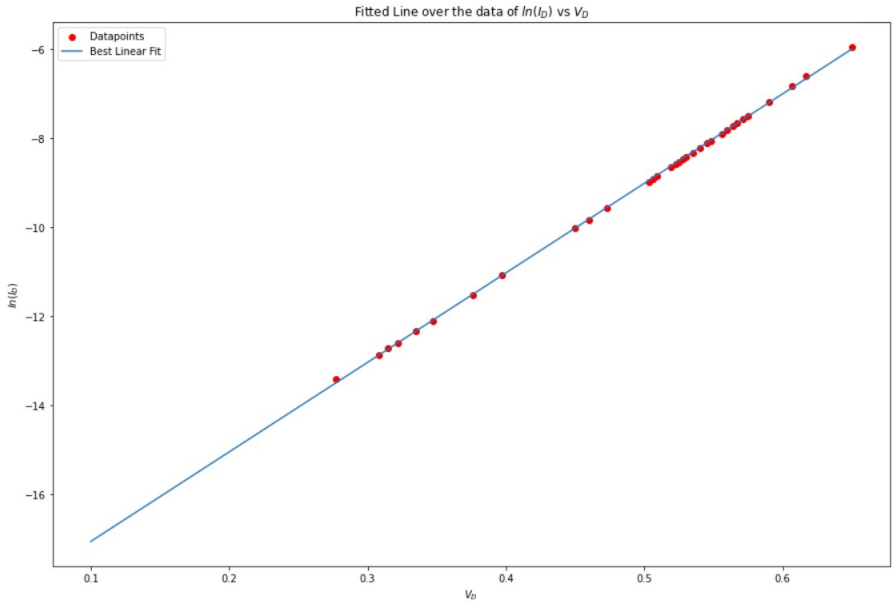

Fig 3: The Linear Regression Model Fitted

On comparing m with $\frac{1}{nV_T}$ and c with $ln(I_S)$, we get the values of $n = 1.9125$ and $I_S = 5.246 \times 10^{-}9$ A

2 Circuit Diagrams

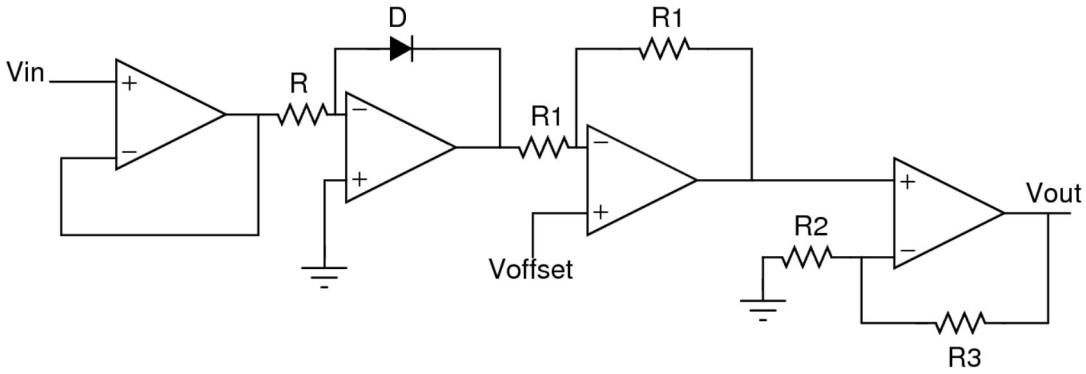

Fig 4: Logarithmic Amplifier

3 Calculation of Parameters for the Logarithmic Amplifier Circuit

Range of currents is I_{D1} to I_{D2}: 1.5×10^6 A - 0.00261 A
$R = \frac{10}{I_{D2}} = 3.83k\Omega$

$V_{offset} = \frac{nV_T log(I_s R)}{2} = -0.268V$

$\frac{R_3}{R_2} = -(1 - \frac{1}{nV_T}) = 19.114$

Thus values of R_1, R_2, R_3 can be taken as $1k\Omega$, $1k\Omega$ and $19.114k\Omega$ respectively.

4 Netlist for the Circuit

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Lab 8 Simulation of Logarithmic Amplifier
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.include 1N4148_1.txt
.include TL084.txt

vin 1 0 dc
vcc 3 0 15
vee 4 0 -15
x1 1 2 3 4 2 TL084
r0 2 6 3.83k
x2 0 6 3 4 7 TL084
d1 6 7 1N4148
r11 7 12 1k
voff 11 0 -0.26
r12 12 15 1k
x3 11 12 3 4 15 TL084
x4 15 17 3 4 20 TL084
r3 17 20 17.153k
r2 17 0 1k
.dc vin 0.006 10 0.1
.control
run
plot v(20)
plot v(20) vs ln(v(1))
print v(20)
.endc
.end
```

5 Comparision of Theoretical and Experimental Graphs

The values of R, R_1, R_2, R_3 were used as before and the parameters were tuned in order to get the best possible fit in the following way.
The value of V_{offset} was chosen such that for $V_{in} = 1$V the output voltage is extremely close to 0V.
also the value of $\frac{R_3}{R_2}$ was scaled such that for an input of 2V the output voltage would be exactly 0.693V. Thus the values taken were $V_{offset} = -0.26V$ and $R_3 = 17.153k\Omega$

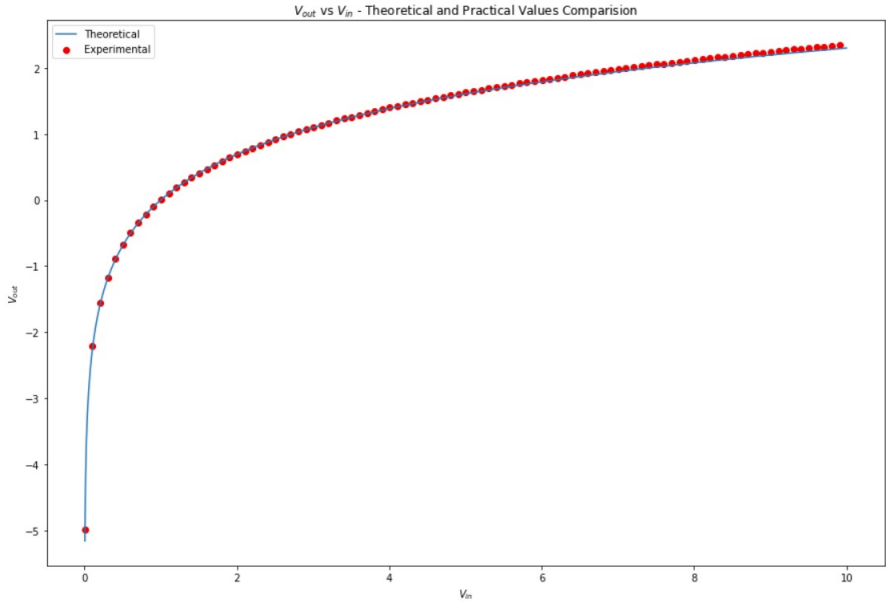

Fig 5: V_{out} vs V_{in} Comparison

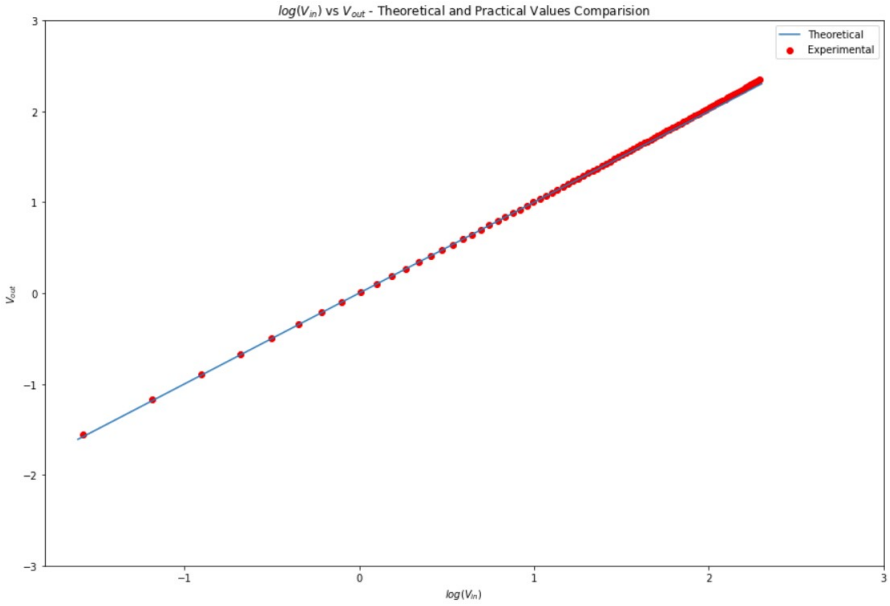

Fig 6: V_{out} vs $ln(V_{in})$ Comparison