EE236 : Electronic Devices Lab
Lab 11 [Tuesday Batch]

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1 Aim of The Experiment

1. **Characterize the NMOS:** Determine the threshold voltage (V_T) and calculate the MOSFET parameter β at room temperature.
2. **Extract Mobility (μ):** Measure drain current (I_D) for various gate-source voltages (V_{GS}) at a fixed V_{DS} and calculate β.
3. **Analyze Temperature Dependence:** Observe changes in β vs V_{GS} plots at 30°C, 50°C, and 70°C.
4. **Quantify Temperature Effect:** Plot β vs temperature at low and high V_{GS} to study mobility trends in NMOS.

2 Design

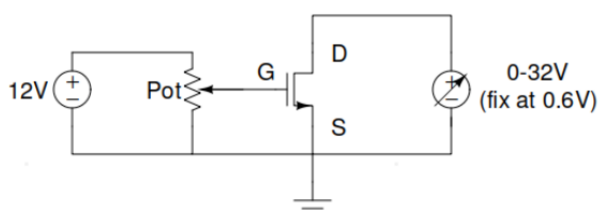

Figure 1: Circuit

3 Part 1

3.1 Plots

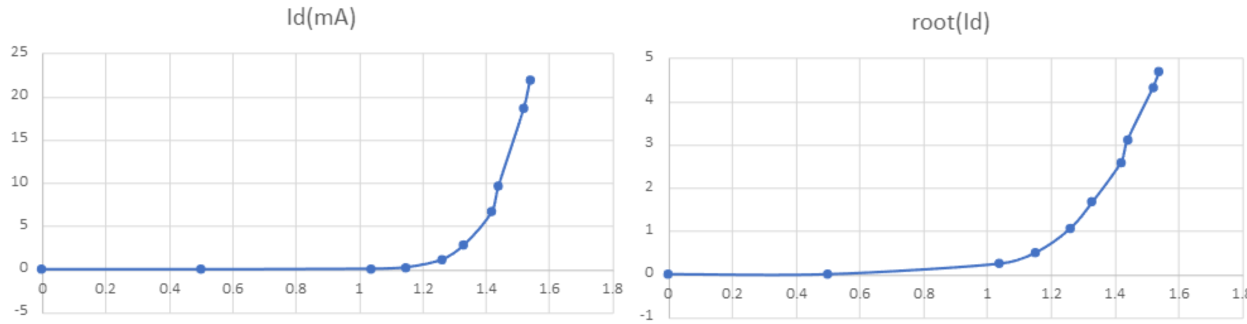

Figure 2: I_d and $\sqrt{I_d}$ vs V_{GS}

3.2 Calculations

$$\sqrt{I_D} = \sqrt{\frac{\beta}{2}}(V_{GS} - V_T)$$

$$\text{slope} = \frac{\sqrt{I_D}}{V_{GS}} = \sqrt{\frac{\beta}{2}} \implies \beta = 2 \cdot (\text{slope}^2)$$

We apply linear regression on the points after the V_T which from the plot is approximately 1.2V. We get the value of slope as 13.10. This value of slope is because current is in mil-

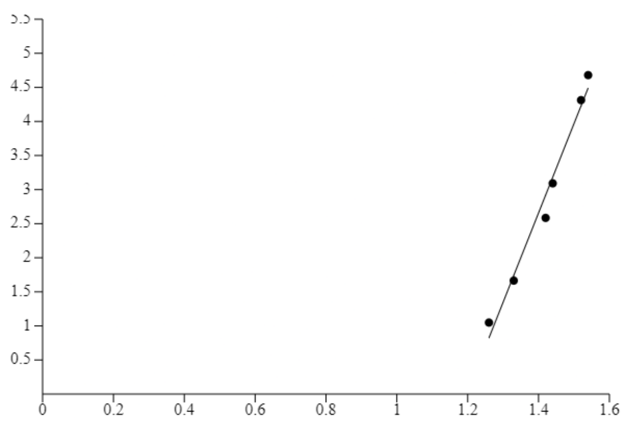

Figure 3: Linear Regression

liamperes. In SI units, the slope is:

$$\text{slope}_{\text{A}} = \frac{\text{slope}_{\text{mA}}}{\sqrt{1000}} = \frac{13.1}{\sqrt{1000}}$$

$$\text{slope}_\text{A} = \frac{13.1}{31.62} \approx 0.414$$
$$\beta = 2 \cdot (\text{slope}^2) = 2 \times (0.414)^2 = 0.342792$$

4 Part 2

4.1 Plots

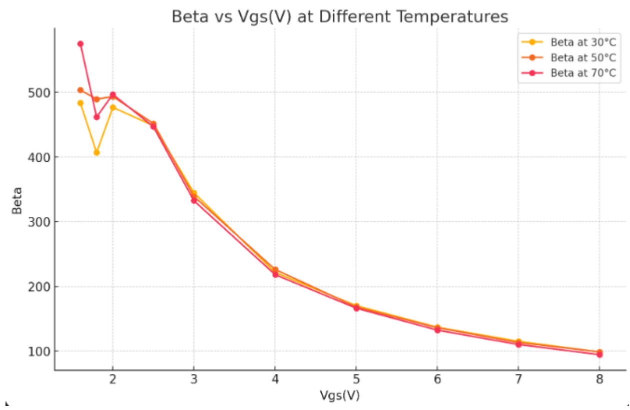

Figure 4: β vs V_{GS}

We see how at low V_{GS} there is high β, and low β at high V_{GS}.

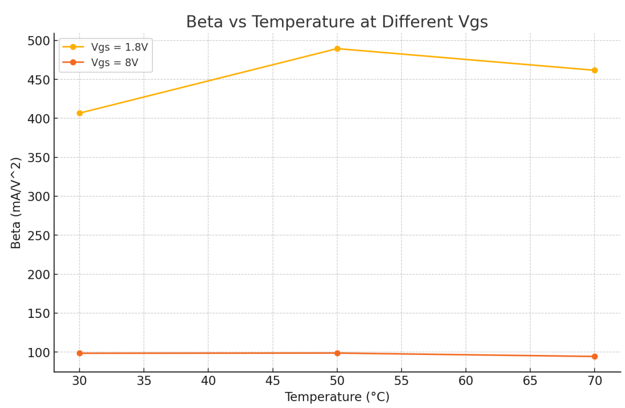

Figure 5: β vs $Temp$ at $V_{GS} = 1.8V and 8V$

4.2 Tables

Temperature (°C)	**Beta at Vgs = 1.8V (mA/V^2)**	**Beta at Vgs = 8V (mA/V^2)**
30	406.67	98.46
50	489.44	98.72
70	461.67	94.36

Table 1: Beta values at different temperatures for Vgs = 1.8V and Vgs = 8V

5 Experiment Completion Status

Successfully completed the experiment.