Project 2

Data Analysis of Monte Carlo Simulation of InGaAs Semiconductor Device

Michael Brunetti

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UMass Lowell

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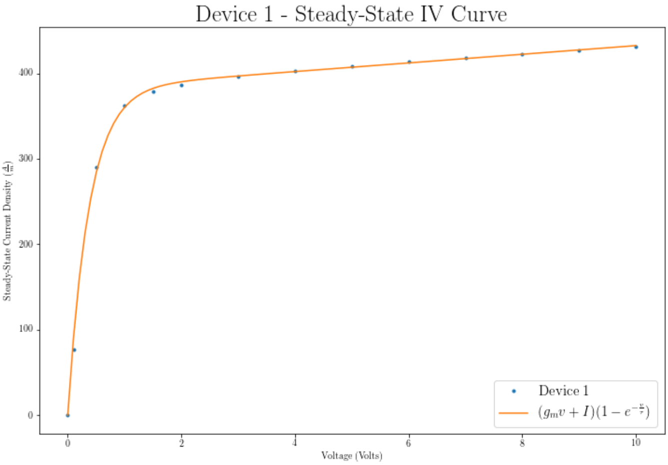
Strategy

- Build on previous work – use least squares curve fit parameters from Project 1.
- Characterize and model steady-state I-V relationship for 3 devices.
- Analyze oscillation frequency vs voltage relationship. Develop a model if possible.

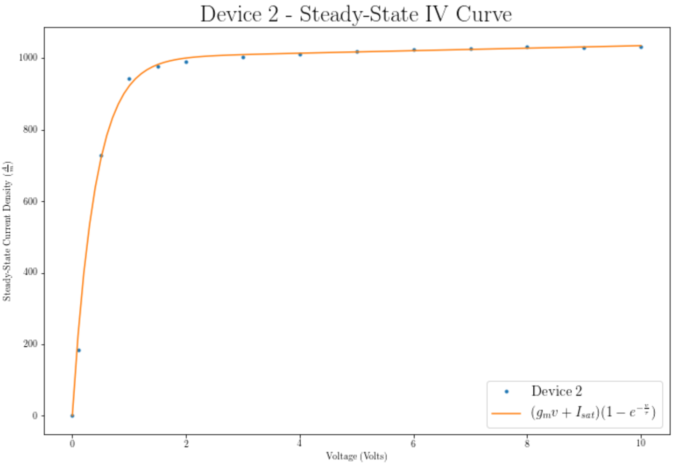
Steady-State I-V Curve – Device 1



Steady-State I-V Curve – Device 1

- Model function: $i = (g_m v + I_{sat})\left(1 - e^{-\frac{v}{\tau}}\right)$
- Exponential rise to saturation, followed by linear IV relationship
- $g_m = 5.06 \frac{\mathrm{A}}{\mathrm{m \cdot V}}$ – "transconductance gain"
- $I_{sat} = 382 \frac{\mathrm{A}}{\mathrm{m}}$ – "zero voltage saturation current"
- $\tau = 0.374\mathrm{V}$ – "exponential decay constant"

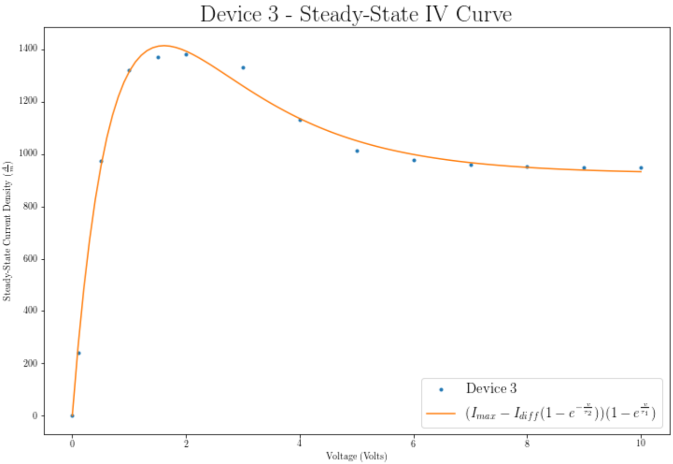
Steady-State I-V Curve – Device 2



Steady-State I-V Curve – Device 2

- Model function: $i = (g_m v + I_{sat})\left(1 - e^{-\frac{v}{\tau}}\right)$
- Exponential rise to saturation, followed by linear IV relationship
- $g_m = 3.51 \frac{\mathrm{A}}{\mathrm{m \cdot V}}$ – "transconductance gain"
- $I_{sat} = 1000 \frac{\mathrm{A}}{\mathrm{m}}$ – "zero voltage saturation current"
- $\tau = 0.398\mathrm{V}$ – "exponential decay constant"

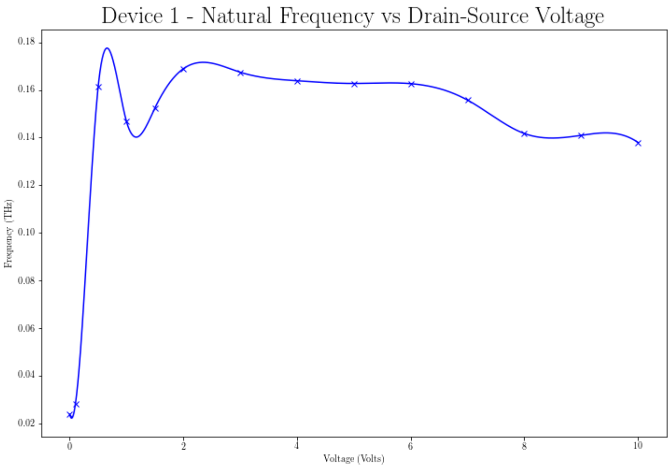
Steady-State I-V Curve – Device 3



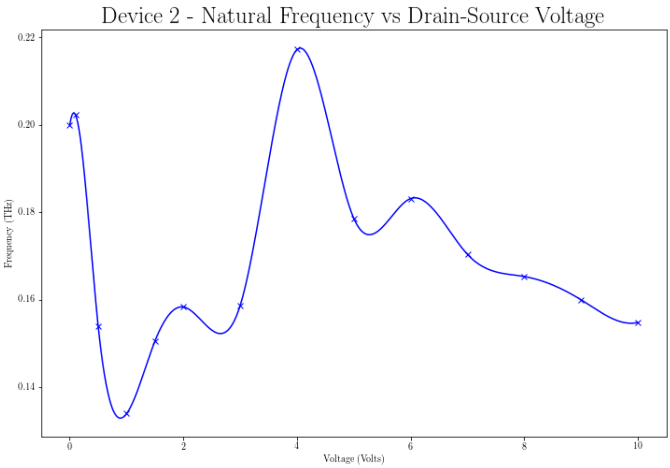
Steady-State I-V Curve – Device 3

- Model function: $i = \left(I_{max} - I_{diff}\left(1 - e^{\frac{v}{\tau_2}}\right)\right)\left(1 - e^{\frac{v}{\tau_1}}\right)$
- $I_{max} - I_{diff} = \lim_{v\to\infty} i = 927\frac{\text{A}}{\text{m}}$
- $\tau_1 = 0.772\text{V}$ – "exponential decay constant for rise"
- $\tau_2 = 1.75\text{V}$ – "exponential decay constant for drop"
- $\tau_1 < \tau_2$

Natural Frequency vs Drain-Source Voltage – Device 1



Natural Frequency vs Drain-Source Voltage – Device 2



Natural Frequency vs Drain-Source Voltage – Device 3