

LAB ASSIGNMENT

Demonstration of TFET Common Source Configuration

Submitted By:

BATCH 4

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Objective:

To design a TFET Common Source Amplifier and calculate the following parameter:

1. Voltage Gain
2. Transconductance
3. Output Impedance
4. Input Impedance
5. Bandwidth
6. Gain Bandwidth Product
7. Voltage Swing
8. Frequency Response Plot

Technology Used: 32nm technology

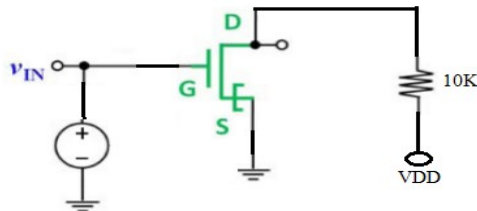


Fig: Schematic of CS amplifier

A) DESIGN OF TUNNEL FET USING DECKBUILD

STEPS:

1. Go to -> Terminal-> gedit
2. Write the code for the tunnel fet
 - Device Structure description
 - Mixed Mode Netlist description
3. Save both the files with .in extension
4. Go to -> Terminal
5. Type -> deckbuild
6. Open file -> Mixedmode_DGFET.in
7. Run the code in deckbuild
8. Open -> Terminal
9. Type -> tonyplot
10. Open the following files in tonyplot
 1. Mixedmode_DGFET.str
 2. Mixedmode_DGFET.log

PHYSICAL PARAMETERS

CHANNEL LENGTH	32nm
SUBSTRATE DOPING (/cm ³)	12.5X10 ¹⁶
INTRINSIC DOPING (/cm ³)	1 X 10 ¹⁷
SOURCE DOPING (/cm ³)	1X 10 ²⁰
DRAIN DOPING (/cm ³)	5X 10 ¹⁹
LOAD RESISTANCE	10Kohms

Structure Of Common Source Amplifier:

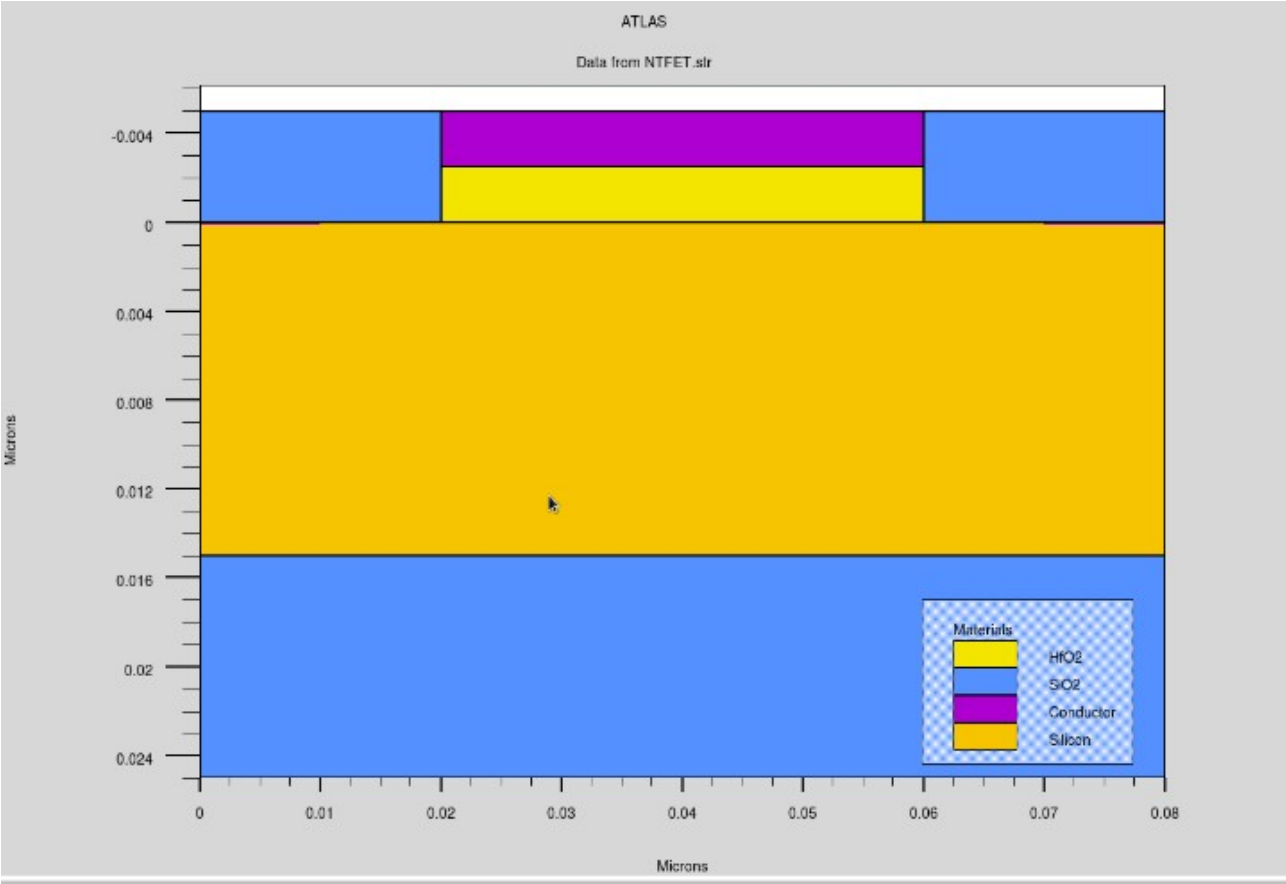


Fig : Structure of CS amplier

Energy Band Diagram:

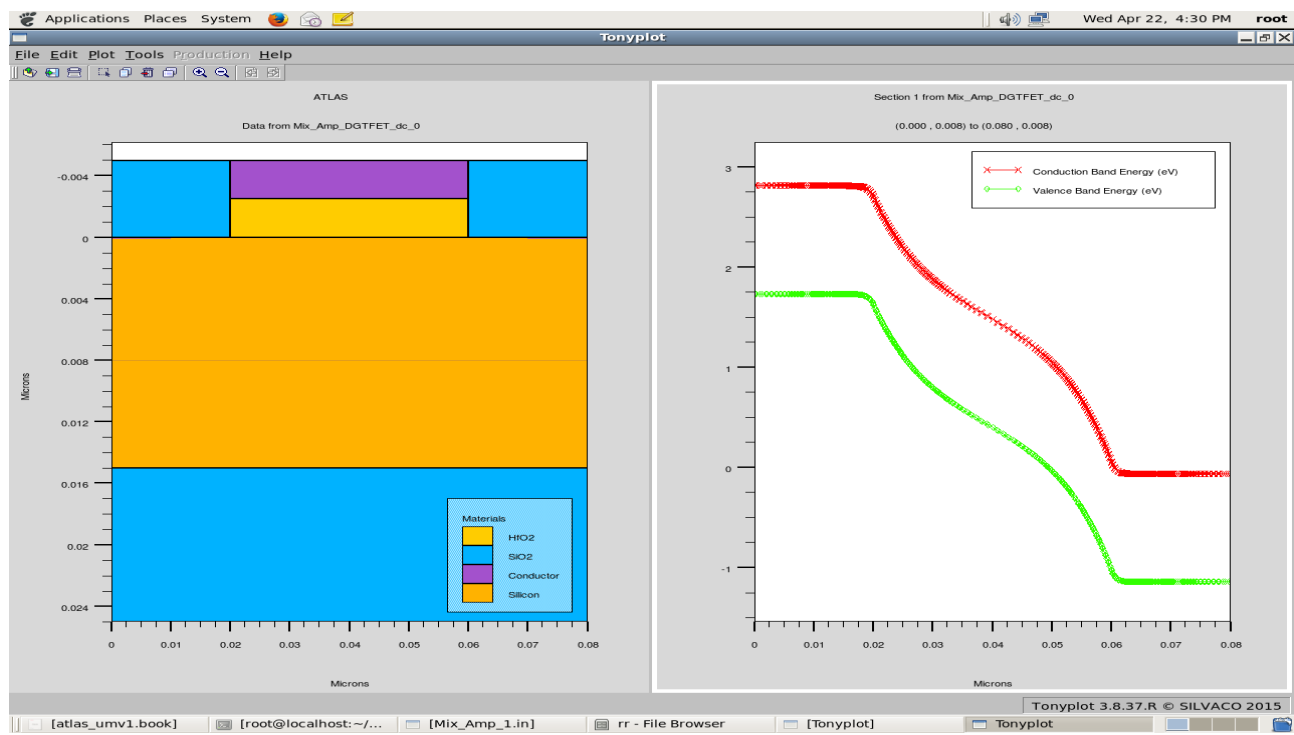


Fig : Energy Band Diagram At 0V

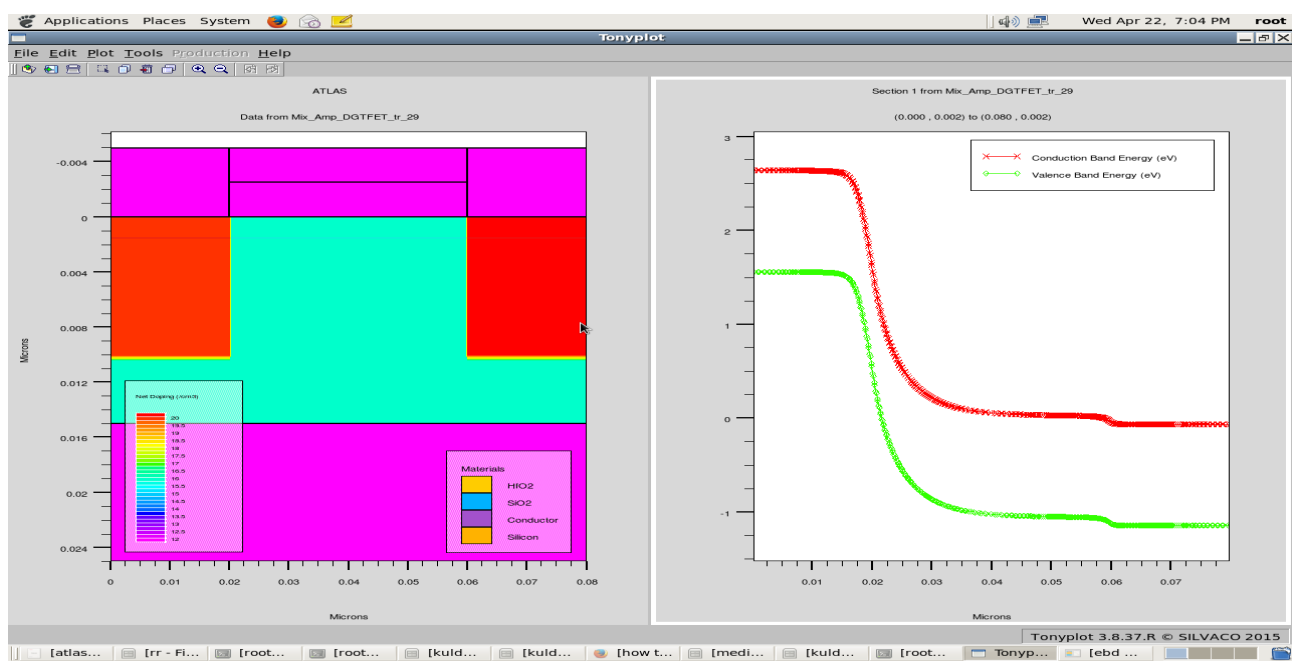


Fig: Energy Band Diagram at 2V

Tunneling Effect:

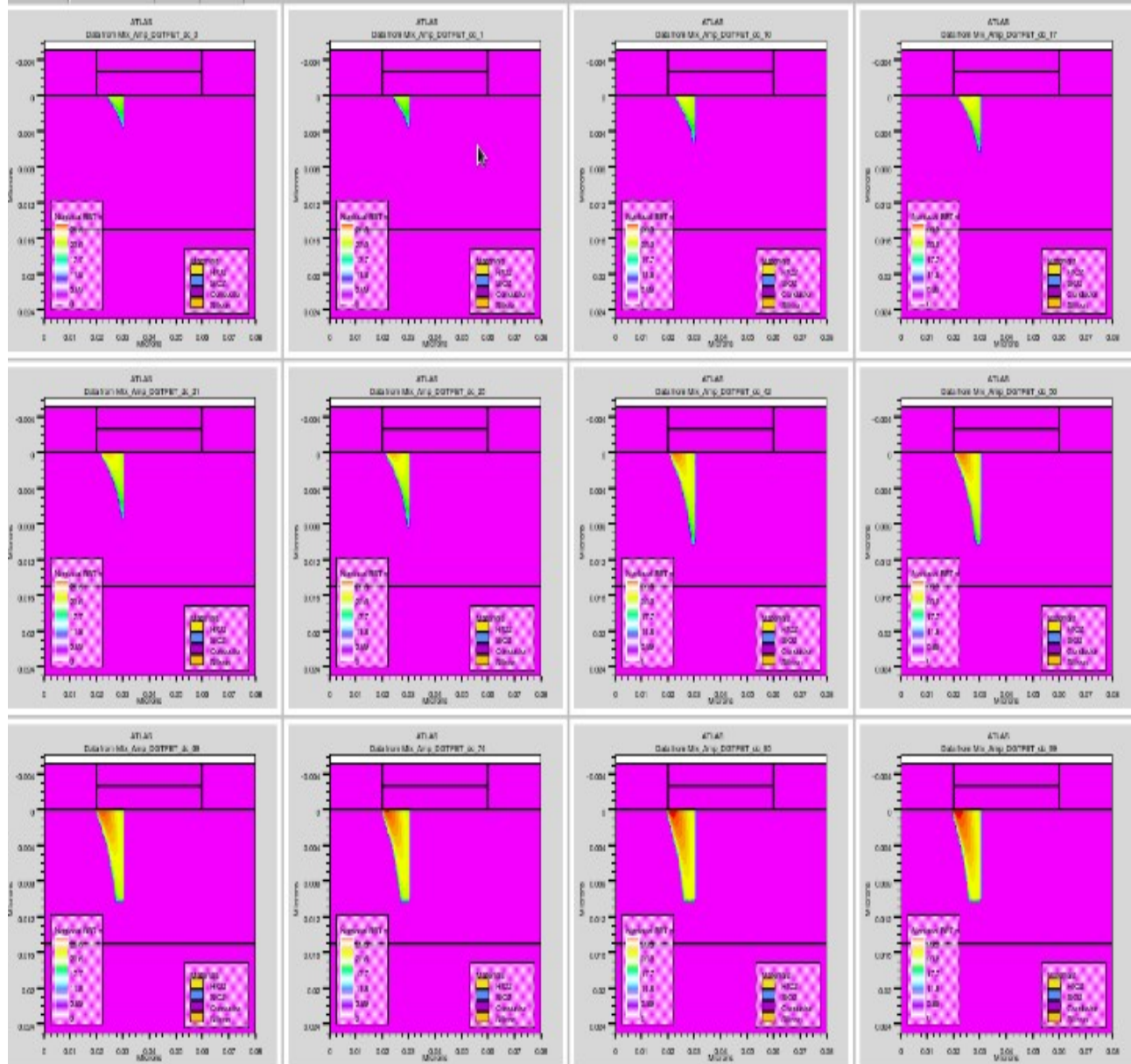


Fig: Band to Band Electron Tunneling

Drain Current Vs Gate Voltage

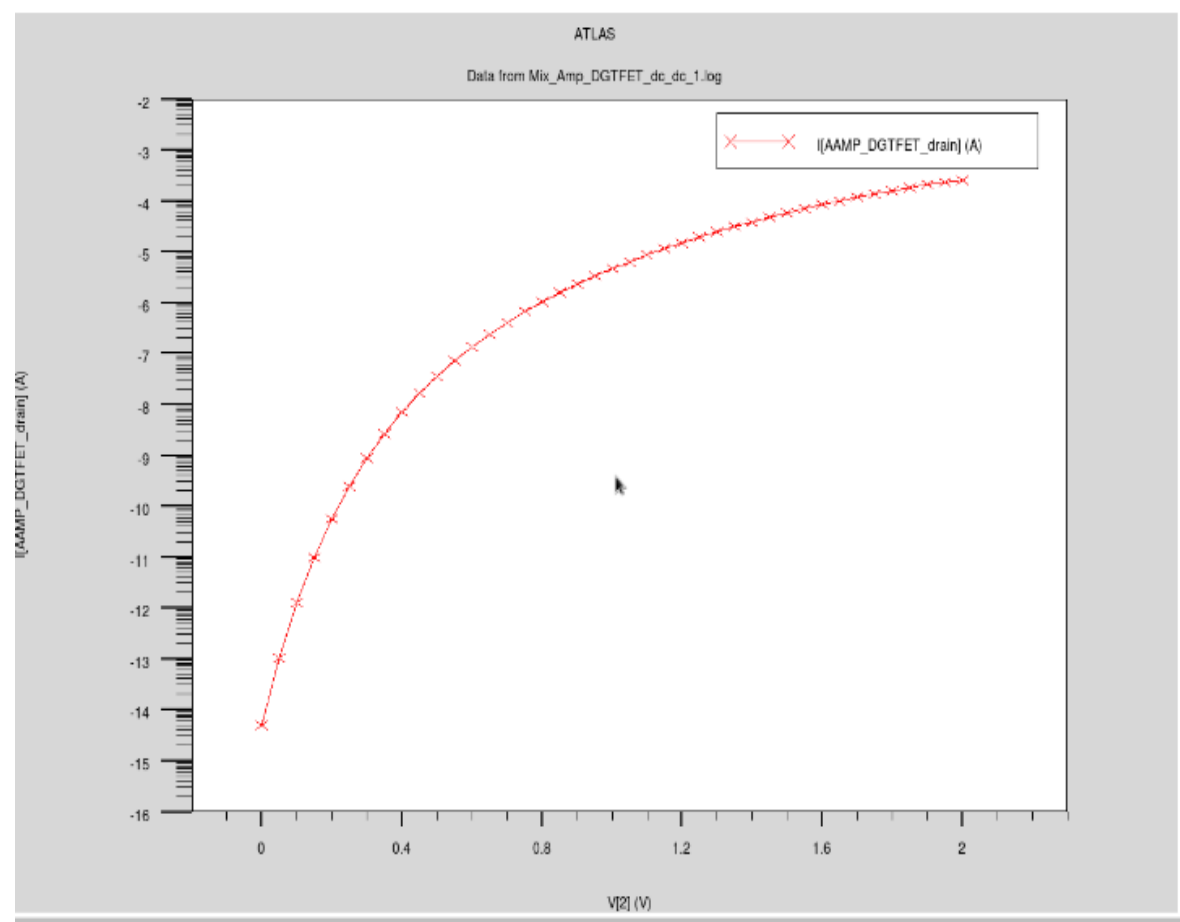


Fig: Log(I_d) vs V_{gs}

Leakage Current= 6.18×10^{-15} Amp

Transconductance:

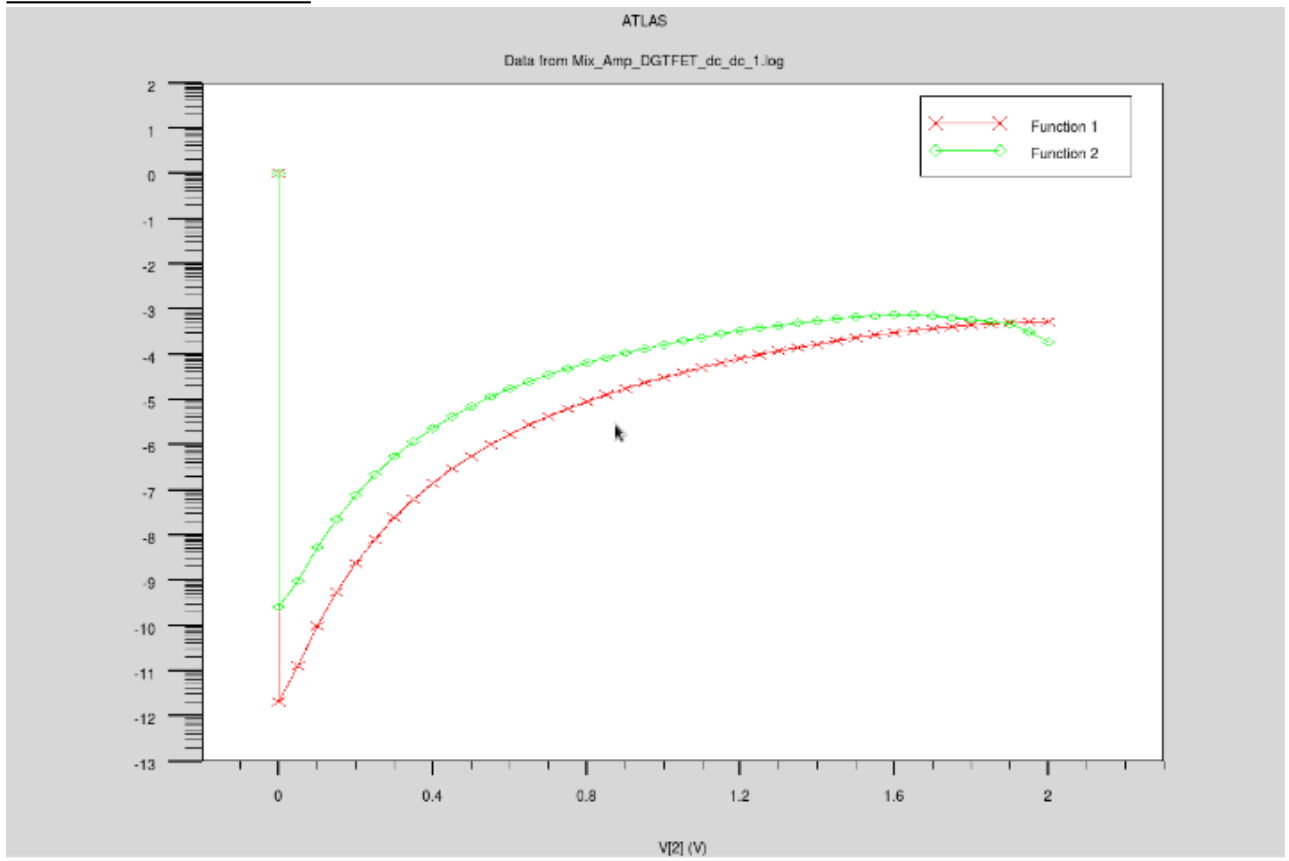


Fig: Transconductance vs V_{gs}

Transconductance $g_m = 520.8 \text{ uAmp/volt}$

Gain of the CS Amplifier:

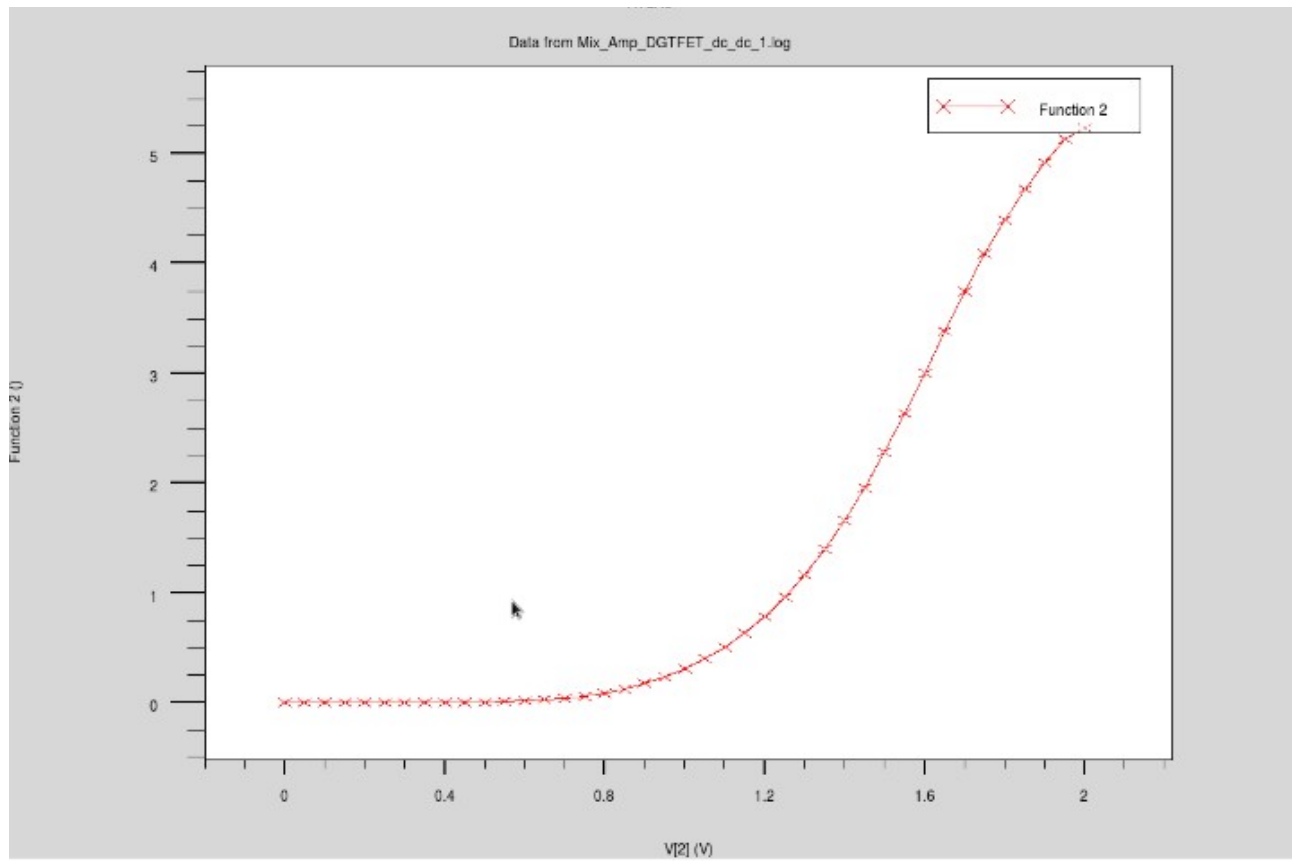


Fig : $|A|$ vs V_{in}

Gain = 14.27 dB

Output Voltage vs Input Voltage:

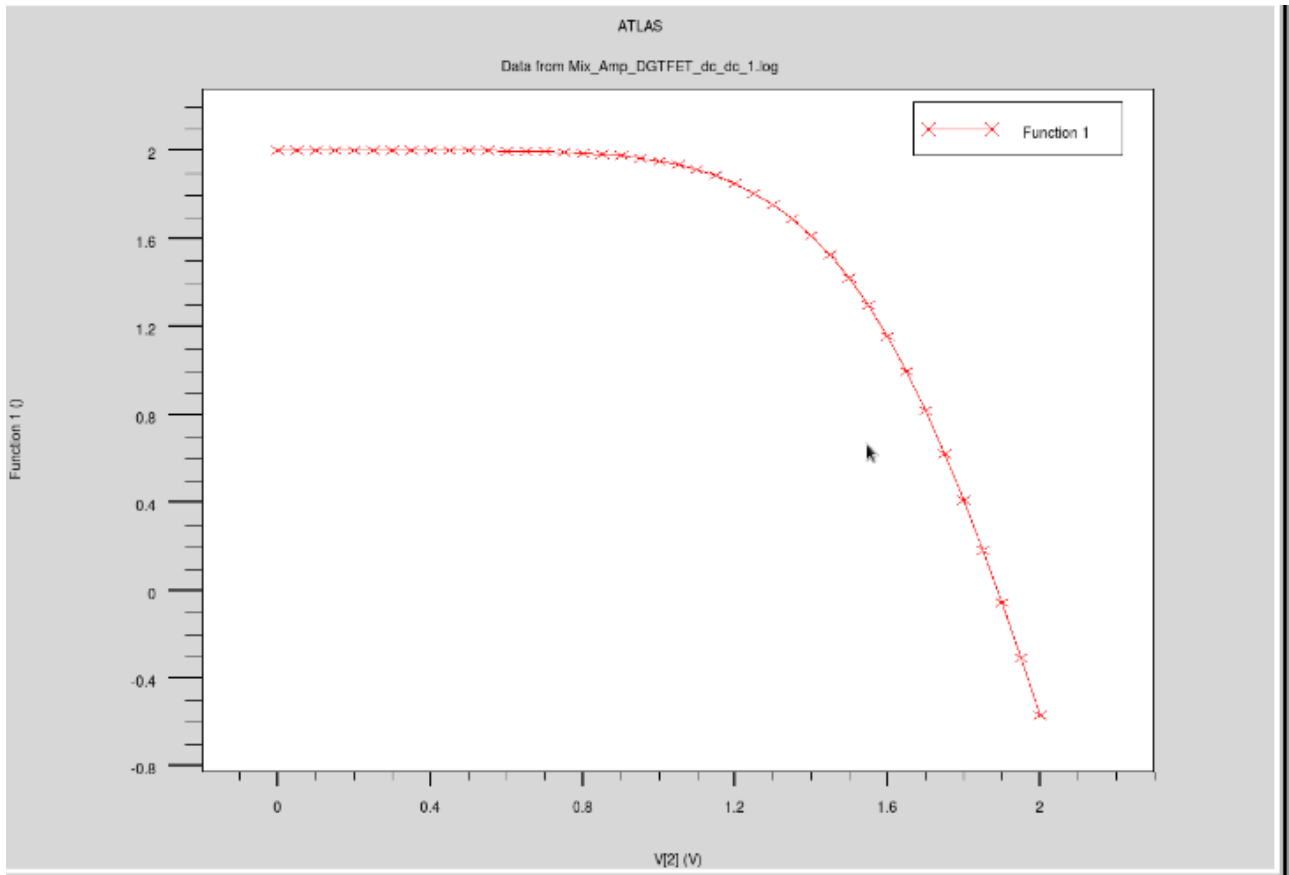


Fig: Vout vs Vin curve

$$V_{out} = V_{dd} - I_d \cdot R_d$$

Voltage Swing:

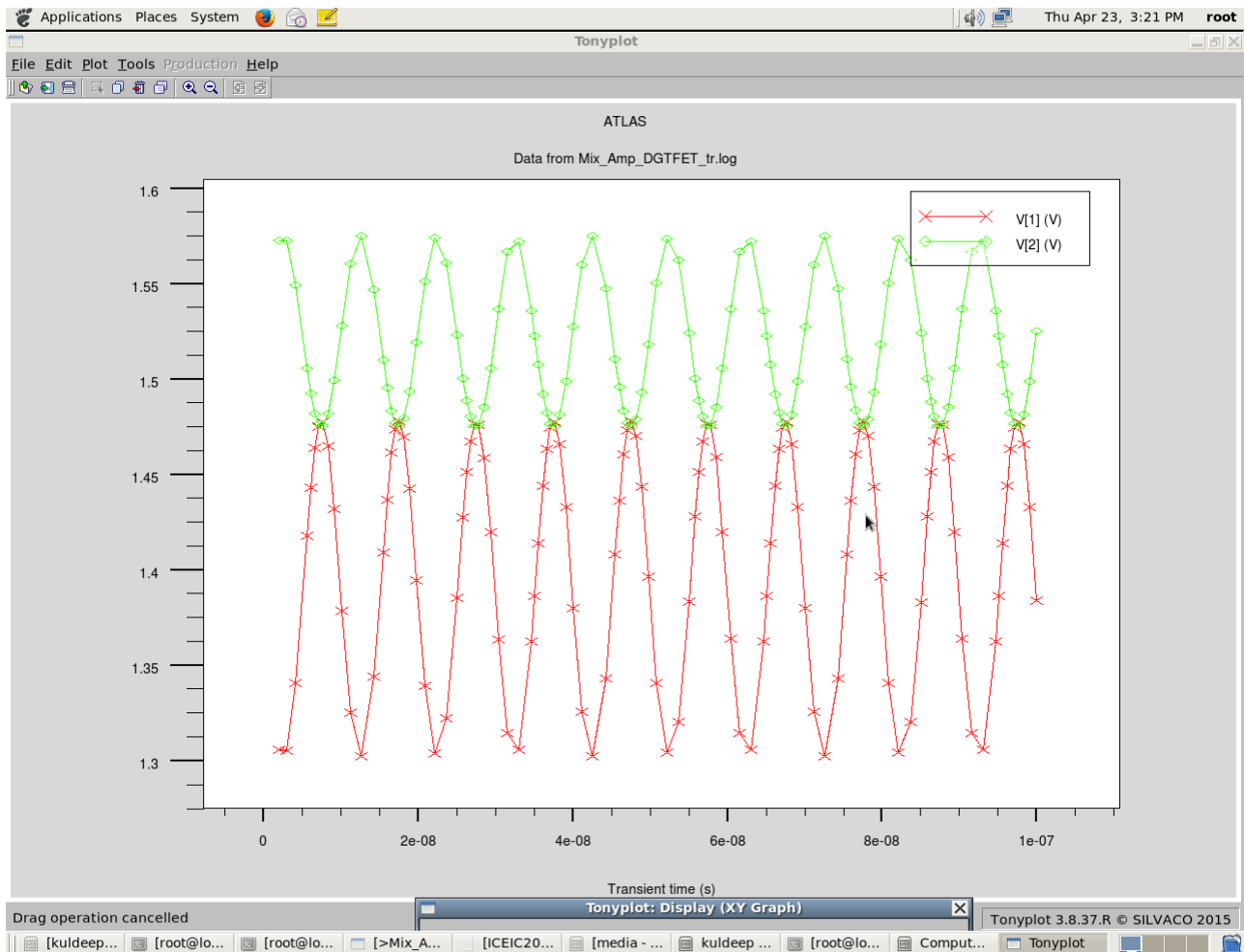


Fig: AC input and output waveforms

Voltage Swing of Input Signal = 1.3V to 1.475V

Voltage Swing of Output Signal = 1.475V 1.58V

Frequency Response:

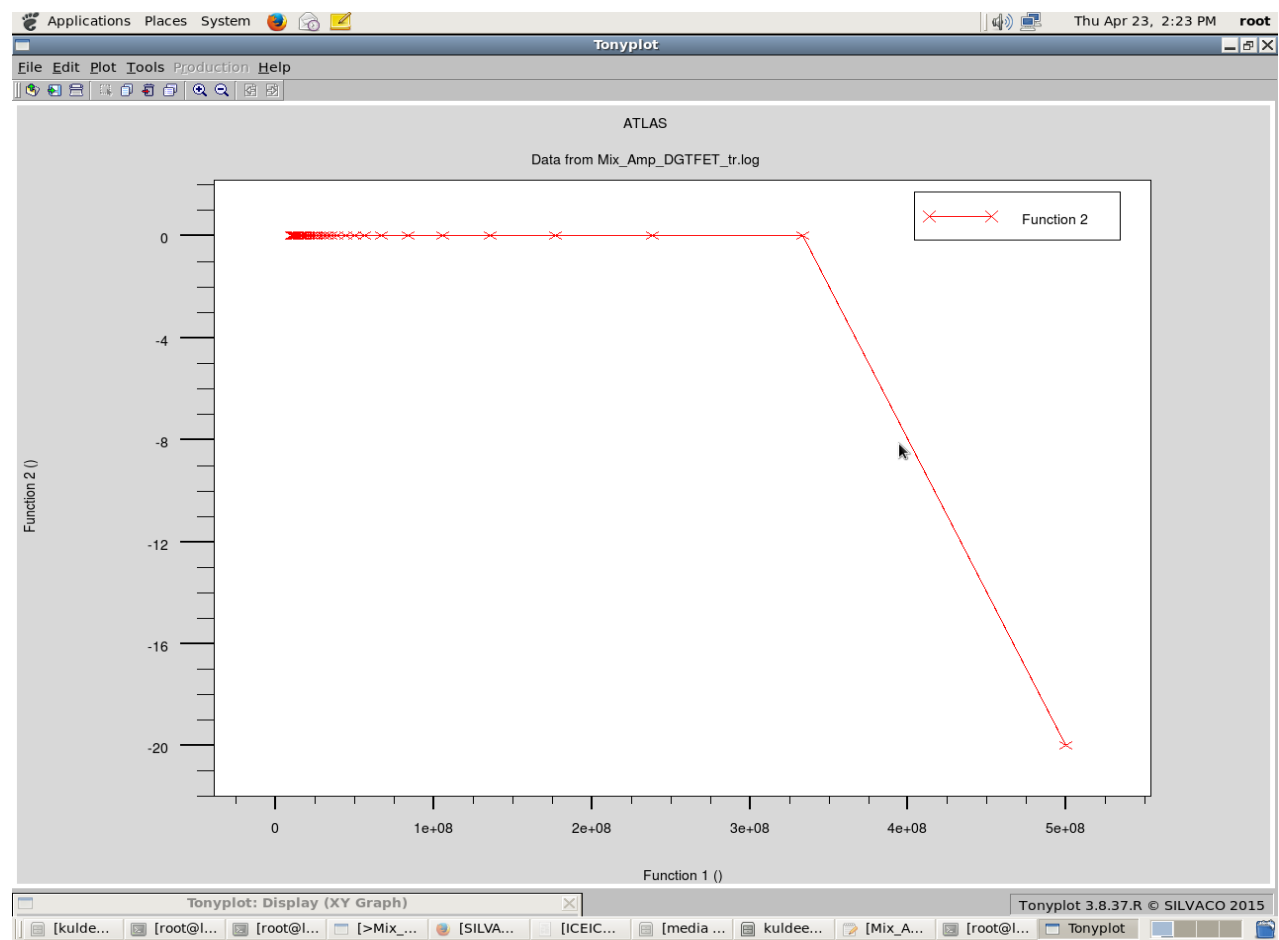


Fig: Gain in dB vs frequency

3dB Bandwidth = 525MHz

Comparison Table:

S.No	Parameters	In CMOS	In FINFET	In TFET
1	Voltage Gain	8.27dB	13.62dB	14.27 dB
2	Transconductance	210uA/V	320 uA/V	520.8 uA/V
3	Input Impedance	6.89Mohms	10^{17} ohms	10^{19} ohms
4	Output Impedance	10 K ohms	10 K ohms	10 Kohms
5	Bandwidth	422.56MHz	4.7GHz	525MHz
6	Gain x Bandwidth	1.094GHz	22.56GHz	2.714GHz
7	Voltage Swing	0.8 to 1V	0.84 to 1V	1.475V to 1.58V

Conclusion:

- The gain and transconductance of the TFET CS amplifier is more than the CMOS and FinFet.
- TFET has less short channel effects.
- TFET has low leakage current.
- Ion/Ioff ratio is high in TFET.