

COLLEGE OF ENGINEERING & TECHNOLOGY

Department: Electronics and Communications Engineering

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Course Title: Modern Electronics Circuits

Course No.: EC560 Assignment 1

Date: March 21, 2014



Basic Transistor Operation

Note: For all transistors:

- Use the 1st Edition of the textbook
- Use -N-MOSFETs with the BSIM model in page 80-82
- Use $W = 100\mu\text{m}$, $L_{\text{gate}} = 0.5\mu\text{m}$, Source and drain dimensions are $W \times 2\mu\text{m}$

Question 1 :

Calculate the following:

- 1a- g_m and g_d at $V_{gs} = 3.3\text{V}$, and $V_{ds} = 100\text{mV}$
- 1b- g_m and g_d at $V_{gs} = 3.3\text{V}$ and $V_{ds} = 3.3\text{V}$.
- 1c- r_o for cases 1a & 1b.

Assume that in short channel, $I_{ds} = I_{dso}(1 + V_{ds}/VA)$, $VA=10\text{V}$, I_{dso} is current at velocity saturation, assuming no short channel effects on V_{to} or L_{eff} .

Check for velocity saturation and channel length modulation for short channel at high V_{ds}

Question 2 :

Assume $V_{gs}=V_{ds}=3.3\text{V}$:

- 2a- For Fig. 3.5 p. 78, find all the capacitances and resistances. Ignore g_{mb} .
- 2b- Calculate transistor ω_T .

QUCS

Question 3 :

Assume $V_{gs}=V_{ds}=3.3\text{V}$:

- 3a- In QUCS, adjust the basic transistor parameters (T_{ox} , U_0 , C_{gso} , G_{do} , C_j , V_{to}).
- 3b- Find cutoff frequency using a single transistor.
- 3c- Using QUCS, draw the equivalent circuit in 2a. Plot the frequency response till 100GHz.
- 3d- Compare results in 2b, 3b, and 3c.

Question 4 :

Using QUCS, DC sweep (please read tutorials at QUCS documentation), verify all answers in Question 1.