

EEE 314 EXPERIMENT #1

BJT INVERTER ANALYSIS

The objective of this experiment is to examine the voltage transfer characteristics of RTL and DTL inverters, to measure their switching times and to compare them with the results obtained from SPICE.

PRELIMINARY WORK

1. Using the parameters $\beta_F=300$, $\beta_R= 5$, $V_{CEsat}=0.2V$, $V_{BEA}=0.7V$, $V_{BEsat}=0.8V$, $V_D=0.7V$.

(a) Calculate the voltage-transfer characteristics of the circuits in Figure 1 and Figure 2 with no load at the outputs (V_{O1} node); (specifically for Figure 1: with no R_{B2} connected, i.e. consider only the first stage.) Give all critical points in your analysis.

(b) Calculate the fan-outs of single stage RTL circuit with noise margins $NM_H=NM_L$. (for the definitions see equations 1.5 and 1.6 in the course textbook.)

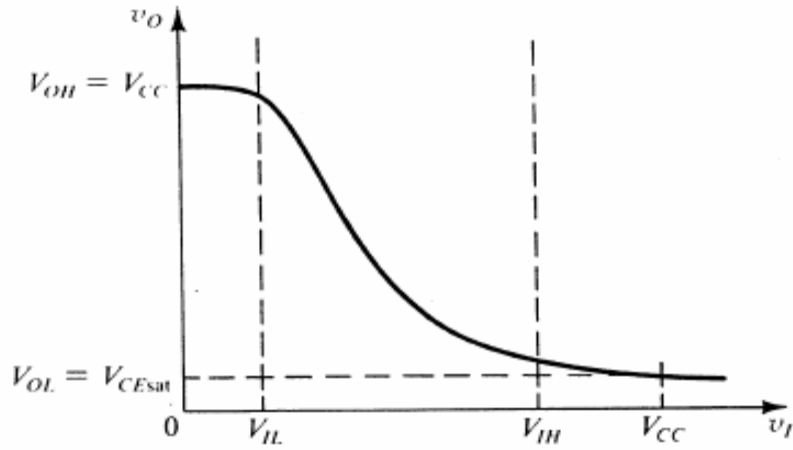
2. Spice Simulation

(a) Simulate the voltage transfer characteristics of both of the circuits with no loads at the outputs as in part 1 (a) by using the spice model (given in the course page) for BC238. Use $R_D=4.7K$ for the DTL circuit.

(b) For the circuits shown in Figure 1 and Figure 2 (first with no R_D), make a SPICE simulation to compute the voltages and times as shown in Figure 3. Compare the simulation results for the circuits. Compare their speed and fan-out characteristics.

(c) Repeat part (b) for the circuit in Figure 1 by adding fast switching diodes to clamp Q1 and Q2 saturation. Use 1N4148 diode spice model in your simulation. The models are already in the default libraries.

(d) Repeat part (b) for the circuit in Figure 2 for different R_D values of $4.7k\Omega$ and $12k\Omega$.



Voltage Transfer Characteristics of an Inverter

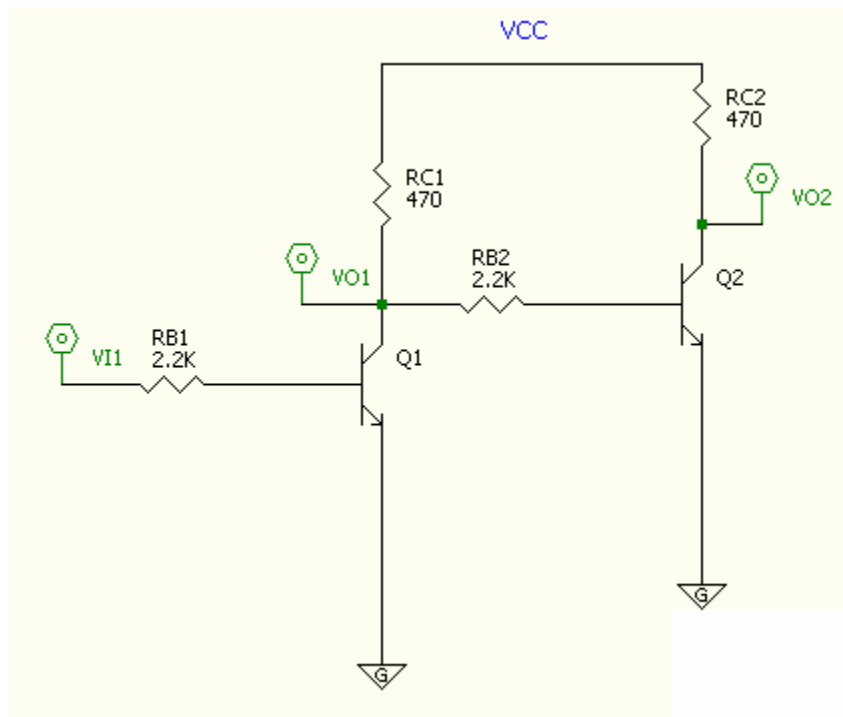


Figure 1

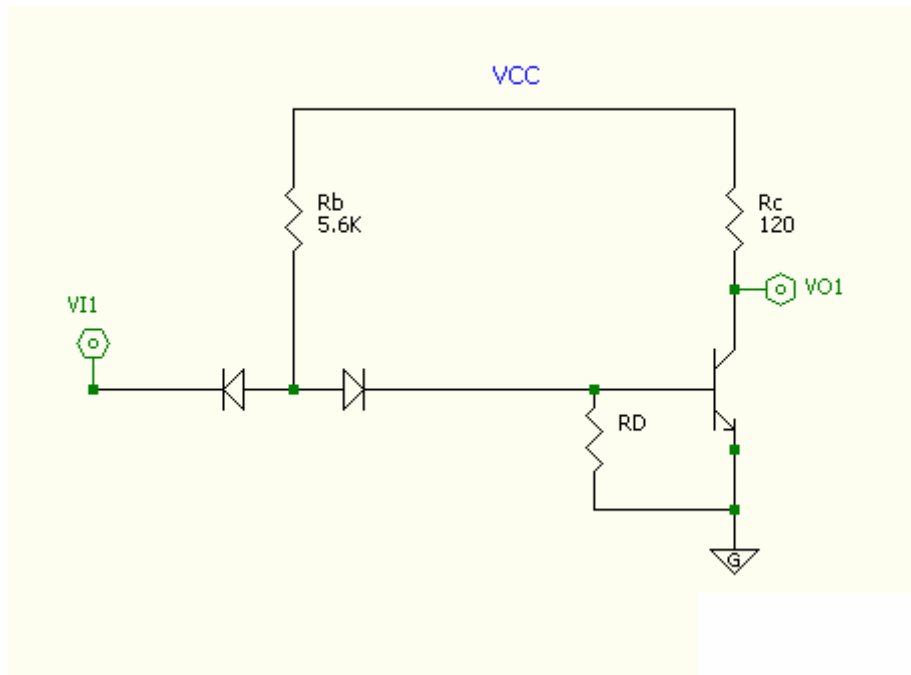


Figure 2

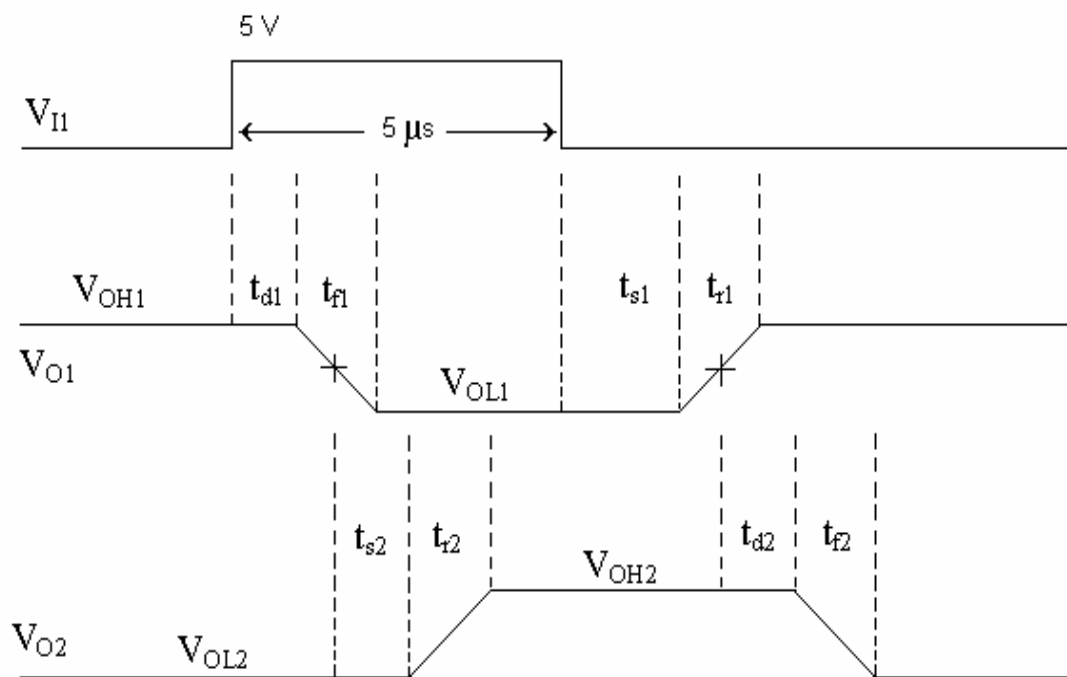


Figure 3

EXPERIMENT

1. Connect the circuit shown in Figure 1 but with no load at V_{O1} .

(a) Plot V_{O1} versus V_{I1} for $V_{O1} = 0V - V_{CC}$, and determine V_{OH} , V_{OL} , V_{IH} , V_{IL} , NM_H , and NM_L .

(b) Connect the circuit shown in Figure 1, with $R_{B2} = 2.2 \text{ k}\Omega$. With a rectangular voltage pulse at V_{I1} , measure the voltages and times as indicated in Figure 3 and sketch the output voltage wave forms. Compare your results to those obtained from SPICE simulation in the preliminary part.

(c) Use 1N4148 fast switching diodes to clamp Q1 and Q2 saturation, and repeat part (b). Determine the states of diodes and transistor junctions when $V_{I1} = 0V$ and $V_{I1} = V_{CC}$. Explain the observed effect of the diodes on time response. Compare your results with the SPICE simulation results in the preliminary part.

(d) Connect a load resistance of $R_{B2}/N=2.2 \text{ k}\Omega$ at the output of first stage (V_{O1}) as in Figure 1, and repeat part (a) to obtain N_{max} so that $NM_H=Nm_L$.

2. Connect the circuit shown in Figure 2 with no R_D .

(a) Plot V_{O1} versus V_{I1} for $V_{O1} = 0V - V_{CC}$, and determine V_{OH} , V_{OL} , V_{IH} , V_{IL} , NM_H , and NM_L . Also determine the states of diodes and transistor junctions when $V_{I1} = 0V$ and $V_{I1} = V_{CC}$.

(b) Connect the circuit shown in Figure 2 as in part (a). With a rectangular voltage pulse at V_{I1} , measure the output voltage V_{O1} and delay time as indicated in Figure 3 and sketch the output voltage wave form. Compare your results to those obtained from SPICE simulation in the preliminary part.

(c) Repeat part (b) for R_D values of $4.7\text{k}\Omega$ and $12\text{k}\Omega$. Compare your results with the SPICE simulation results in the preliminary part and comment on the effect of R_D on the voltage transfer characteristics.

EEE 314 EXPERIMENT #5 DATASHEET

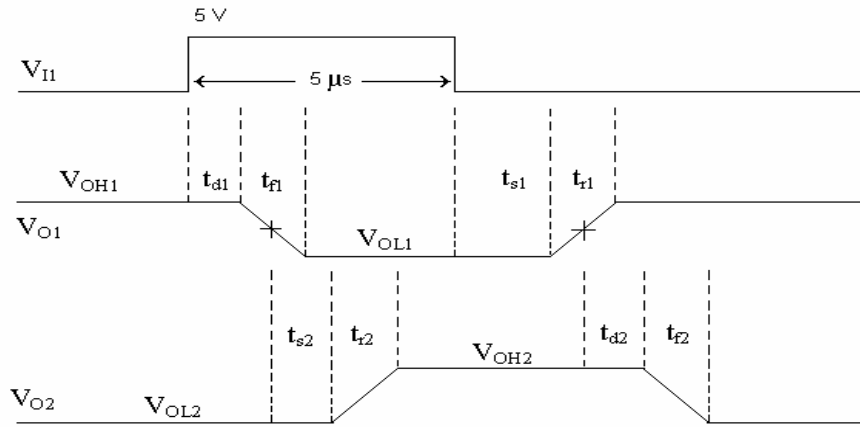
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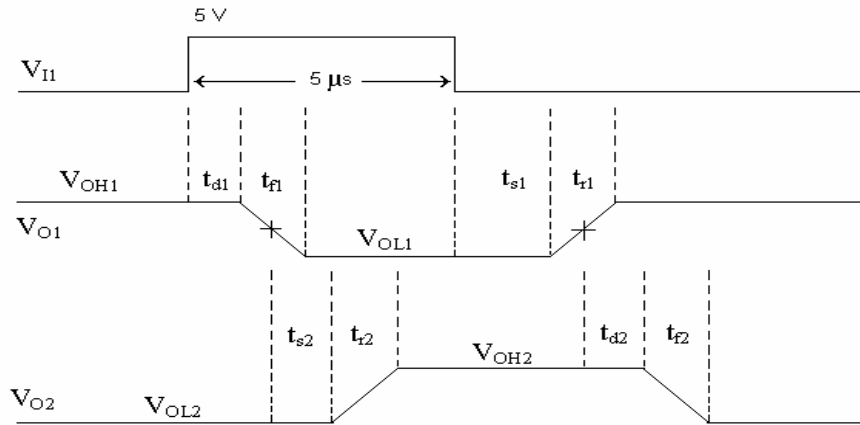
1.

Part	V _{OH}	V _{OL}	V _{IH}	V _{IL}	NM _H	NM _L
1 (a)						

(1 b)



(1 c)



States	D1	D2	Q1 B-E	Q2 B-E	Q1 B-C	Q2 B-C
1 (c) at V _{I1} = 0						
1 (c) at V _{I1} = 5						

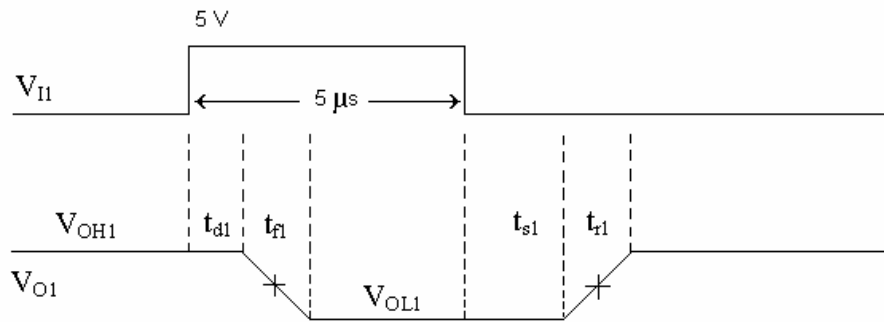
Part	V _{OH}	V _{OL}	V _{IH}	V _{IL}	NM _H	NM _L
1 (d)						

2.

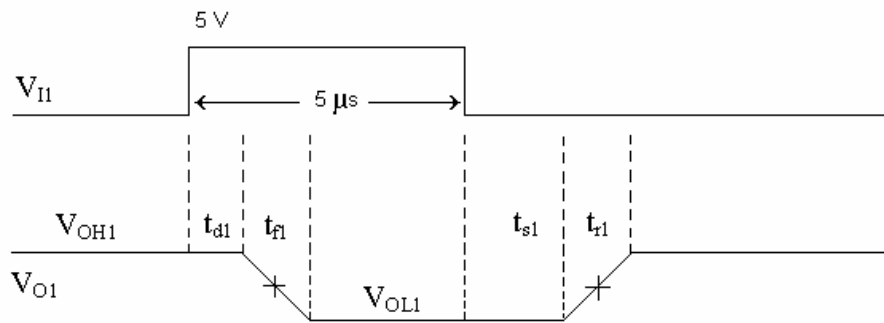
Part	V_{OH}	V_{OL}	V_{IH}	V_{IL}	NM_H	NM_L
2 (a)						

States	D1	D2	Q1 B-E	Q1 B-C
2 (a) at $V_{I1} = 0$				
2 (a) at $V_{I1} = 5$				

2 (b)



2 (c) $R_D = 4.7\text{k}\Omega$



2 (c) $R_D = 12\text{k}\Omega$

