TECHNISCHE UNIVERSITÄT DARMSTADT

Fundamentals of Electronics
Extract from the Winter Semester Examination (English Translation)
2 Subjects out of 4

2. Subject: MOSFET-Circuits (14 Points)

2.1 Mark the terminals of the transistors with B (Bulk), G (Gate), D (Drain), and S (Source)(Fig. 2.1). Assume $V_{DD} = 5V$.

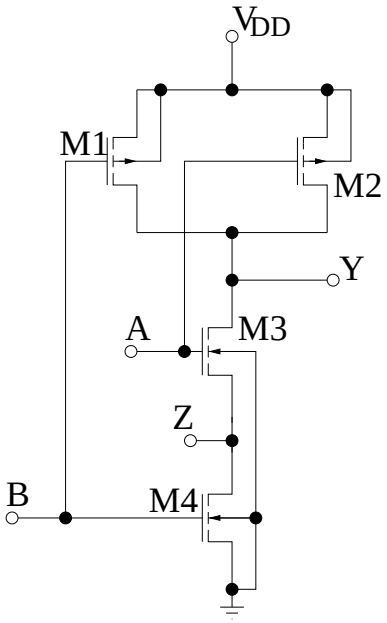

Figure 2.1: Circuit 1

2.2 Which logic function $Y = Y(A, B)$ is implemented in the circuit represented in Fig. 2.1 implementiert?

Y=

2.3 Which is the voltage of the node Z in Fig. 2.1, if $V_{DD} = 5V$ and the voltages of the nodes and B are $5V$ and $0V$ respectively.

$V_Z =$

2.4 Assume $V_A = 5V$, $V_B = 0V$, and $V_{DD} = 5V$. Specify the states of the transistors in the circuit represented in Fig. 2.1

- M1:
- M2:
- M3:
- M4:

2.5 Dimension the transistors of the circuit represented in Fig. 2.1 so that the circuit switches two times faster than a symmetrical inverter with the channel length of the NMOS of $1\mu m$. Assume $\mu_n = 2.5\mu_p$.

- M1: W= L=
- M2: W= L=
- M3: W= L=
- M4: W= L=

3. Subject: Bipolar Transistor - Amplifiers (20 Points)

3.1 Evaluate following affirmations:

	Yes	No	Don't Know
The Bipolar Transistor is called bipolar, because it is a symmetrical element, i.e. it is functioning identically when interchanging the collector and the source.			
The Bipolar Transistor has an infinit output resistance when considering the Early-Effect.			
The Amplifier represented in Figure 3.1 is an Emitter-Follower.			

Note: One can accumulate maximum 3 points and minimum 0 points. Every question is weighted with 1 point. False answers lead to deduction and 'Don't know' answers are not assessed.

3.2 The following circuit is given:

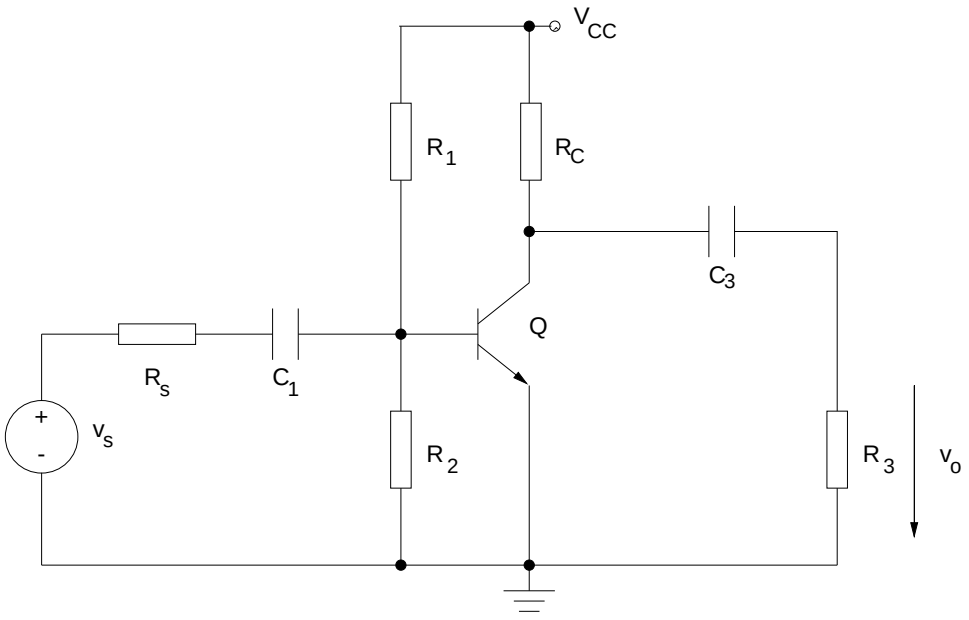

Figure 3.1: Single-Stage Amplifier

Identify the Collector, Base, and Emitter of the Transistor and determine the Q-Point $(I_C; V_{CE})$. Specify I_C as a function of β_F, V_{CC}, R_1, R_2 and V_{BE}. Assume that the transistors works is the Forwards-Active Region and $V_{BE} = 0.7V$. β_F is considered to be known and the Early-Effect can be neglected.

3.3 Determine $g_m = g_m(I_C, V_T)$ from the quadripole description of the transistor (Y-Parameter).

3.4 Draw the Small-Signal model of the circuit. The input-resistance r_π of the transistors is considered to be known. The Early-Effect can be neglected.

3.5 Evaluate the Voltage Amplification of the circuit:

$$A_V(R_S, R_1, R_2, R_3, R_C, g_m, r_\pi) = \frac{v_o}{v_s}.$$