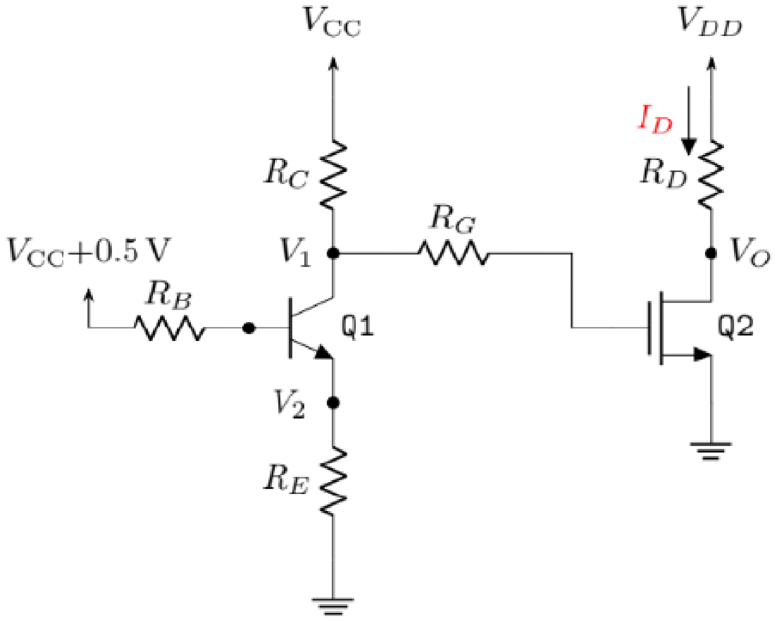
Problem-1

Answer the questions **(a-d)** based on the circuit shown below. the parameter values of the circuit are given in the adjacent table:



Resistor values in (kΩ)

R_B	R_C	R_E	R_G	R_D
100	1.1	1	3	-

Supply Voltages

V_{CC} =5 **V**
V_{DD} =10 **V**

Transistor Parameters

Q1	Q2
$\beta = 100$	$k_n' = 0.25\,\text{mA/V}^2$
$v_{CE(Sat)} = 0.2\,\text{V}$	$W/L = \frac{0.72\ \mu m}{0.18\ \mu m}$
$v_{BE(Act)} = v_{BE(Sat)} = 0.7\,\text{V}$	$V_T = 1\,\text{V}$

Active	Saturation
I_B= 0.024	I_B= 0.025
I_c= 2.4	I_c= 2.273
I_E = 2.424	I_E = 2.3
V_{CE}= -0.064	V_{CE}= 0.2 v
	V_1 = V_c= 2.5
	V_2 = 2.3

I_D= 1.125
R_D= 7.5k

Based on the above scenario, answer the following questions:

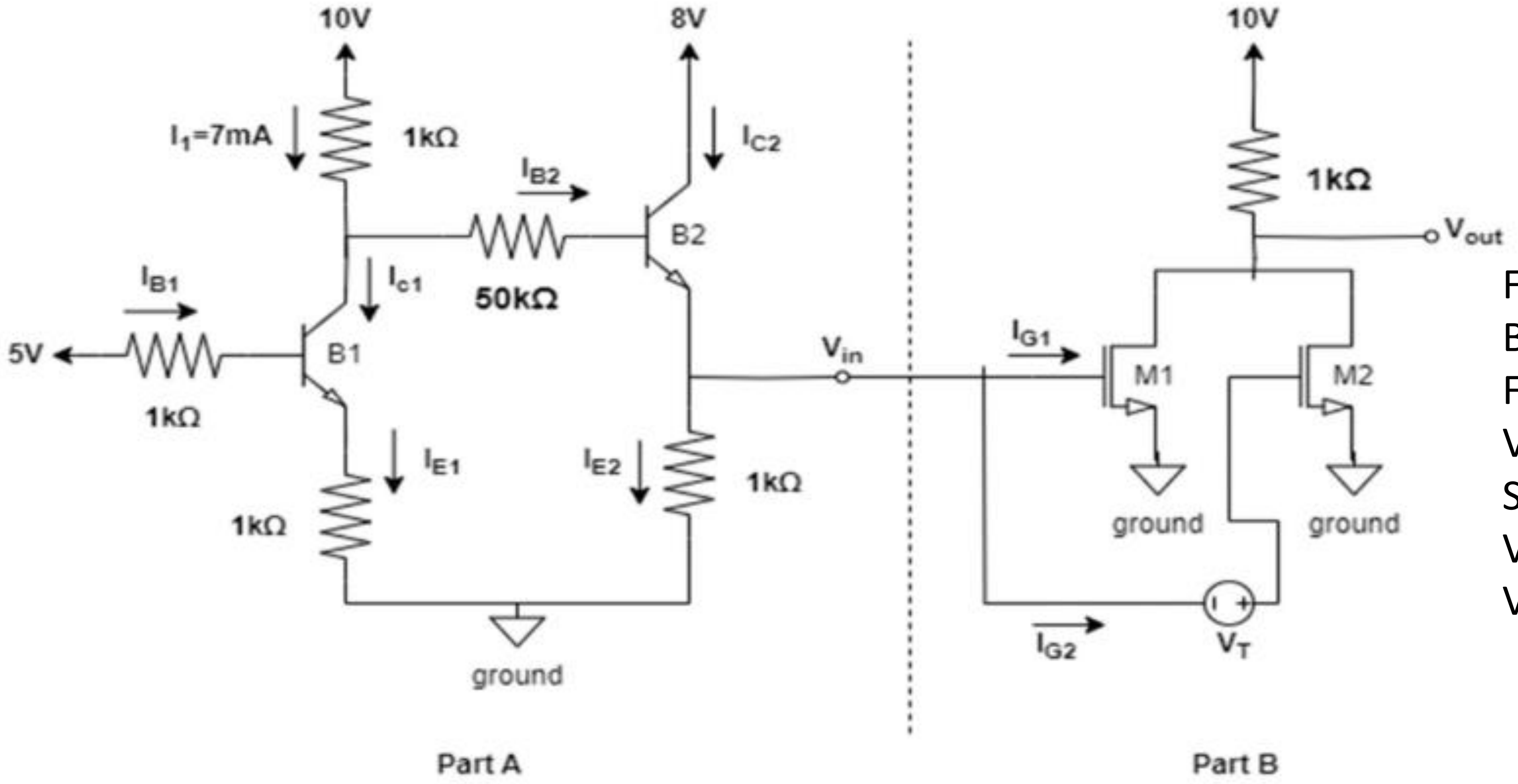
(a) **[CO1]** In the Switch Model of BJT, **Determine** in which mode does a BJT operate when it is OFF? Which mode does it operate in when it is ON? [2]

(b) **[CO2]** **Find out** the currents going through the three terminals of the transistor Q1. [4]

(c) **[CO2]** **Determine** the the value of V_1 and V_2. [1]

(d) **[CO3]** **Design** the circuit, i.e. find an appropriate value of R_D, such that Q2 remains at the edge of saturation, i.e., when $V_{DS} = V_{GS} - V_T$. [3]

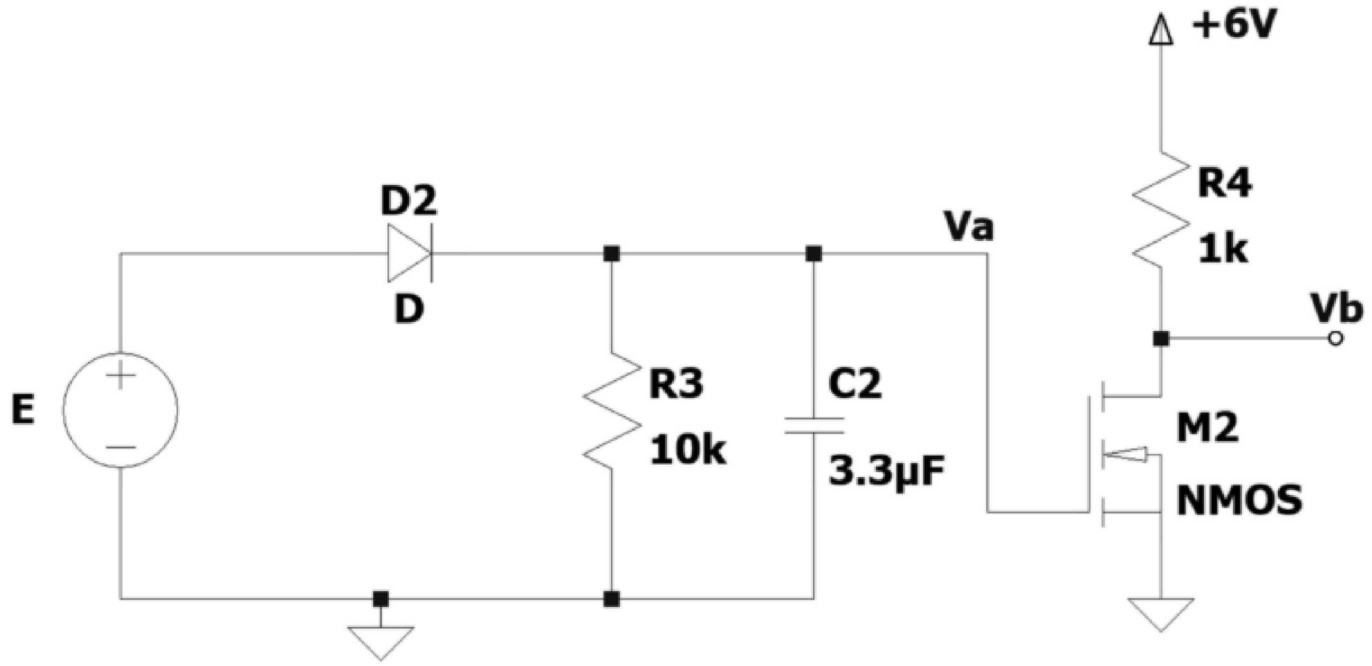
Problem-2



For BJTs
B=100
Forwar Active:
V_{BE} = 0.7 V
Saturation:
V_{BE} = 0.8 V
V_{CE} = 0.2 V

a) Determine i_{g1} and i_{g2}.
b) Assume B_1 and B_2 are in the saturation region. Calculate i_{C2}.
c) Assume B_1 is in the forward active region. Calculate V_{in}.
d) Draw the VTC of part-B assuming V_T = 8 V. [Use S model of MOSFETs]

Problem-3



The <u>Half-wave rectifier</u> circuit has been cascaded with an inverter. You are given the following information about the circuit: **[For HW: $V_o = V_{dc} \pm V_{ripple}/2$]**

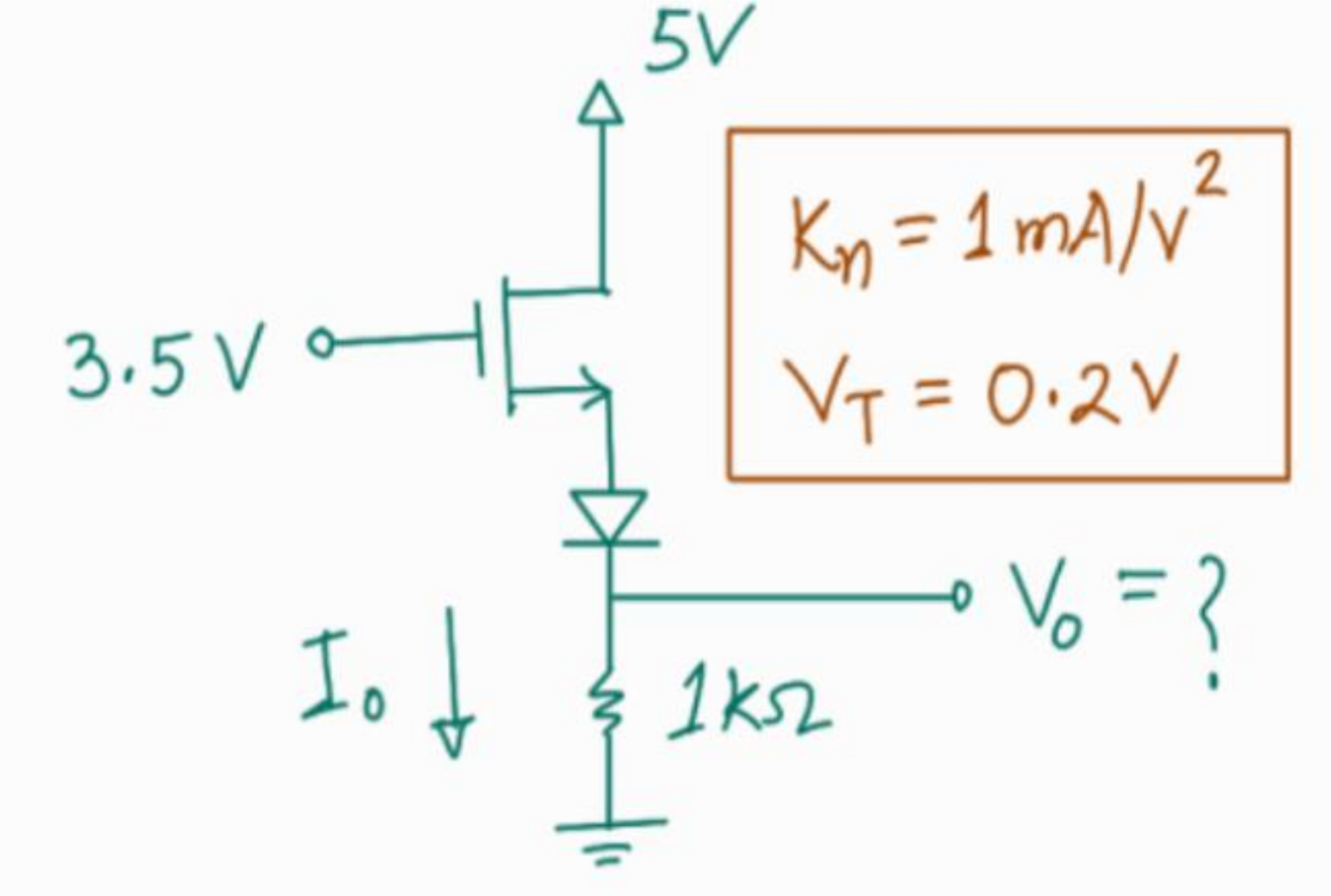
$E = 6\, sin(400\pi t)\, V$	$K_n = 2\, mA/V^2$	$V_T = 1\, V$	$V_{Do} = 0.7\, V$

(a) **Determine** the peak-to-peak ripple value of the half-wave rectifier output, V_a . What is the lowest value of V_a? *[3+1]*

(b) At the lowest value of V_a , **determine** the output V_b of the inverter. *[4]*

(c) Now disconnect the capacitor. In this case, **find out** the voltage V_b for the lowest value of V_a. *[2]*

Problem-4



Problem-5

Kn= 5 mA/V^2
$V_T = 1\ V$

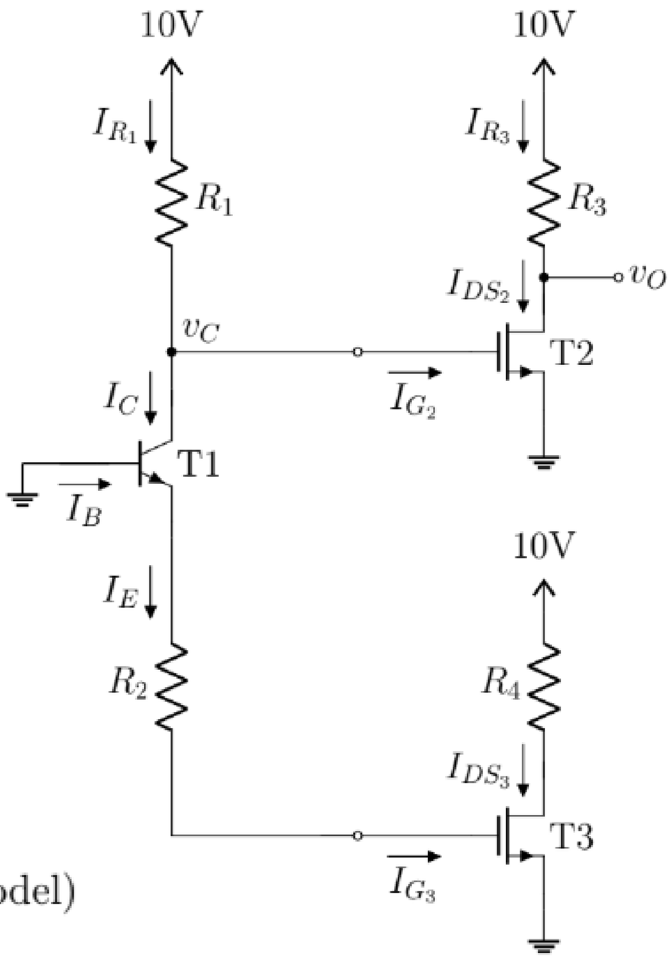


Figure-1

Answer the following questions for <u>***Figure-1***</u> where $R_1 = 1\text{k}\Omega$, $R_2 = 2\text{k}\Omega$, $R_3 = 3\text{k}\Omega$, $R_4 = 4\text{k}\Omega$.

(a) Why a MOSFET can be used as a switch? **Explain** briefly.

(b) **Analyze** the circuit in *Figure-1* to **determine** the values of I_C, I_B, I_E, v_C of T_1.

(c) **Analyze** the circuit in *Figure-1* to **determine** the value of I_{DS_2}, v_O of T_2.

Bonus: **Design** a circuit with the boolean inputs A, B, C, D using ideal MOSFETs (S-model) implement the logic function, $f = \overline{A.C} + B.D$