EECS 42 – UC BERKELEY – Fall 1999/ (F. Shoucair) – 17 November 1999

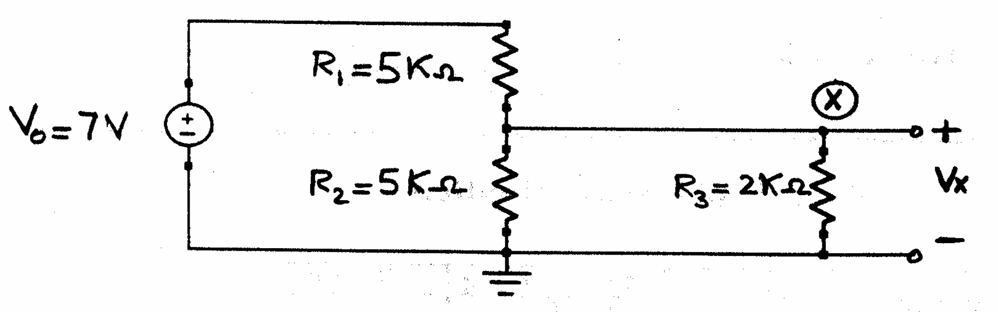
Quiz # 2

1. All OPAMPs in this problem are assumed to be IDEAL.

(a) Draw the schematic of a VOLTAGE FOLLOWER (or BUFFER) OPAMP circuit. Define, mathematically and in words, the parameter A' of this OPAMP circuit, Derive the numerical value of A' for this circuit.

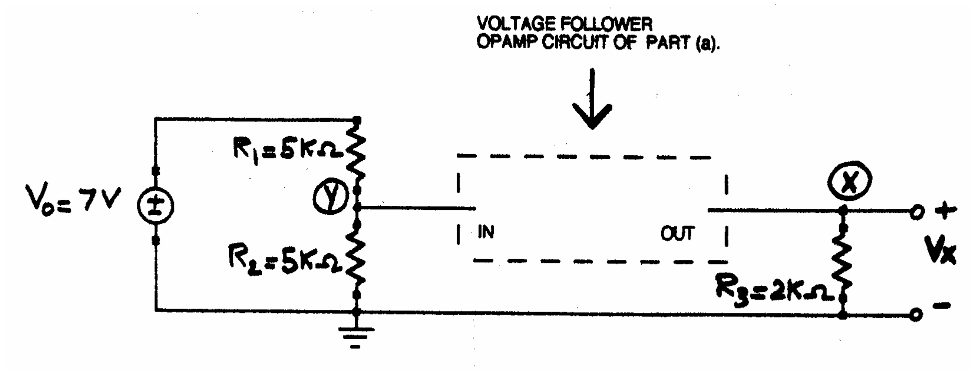
Label your schematic carefully, state all assumptions you make explicitly, and justify each step of your derivation in detail.

(b) Find the numerical value of V_x (in Volt) for the given circuit.



1. (Continued)

(c) Insert your VOLTAGE FOLLOWER of part (a) between nodes Y and X in the circuit shown below (i.e. fill in the dashed box), and find the numerical value of V_x (in Volt).

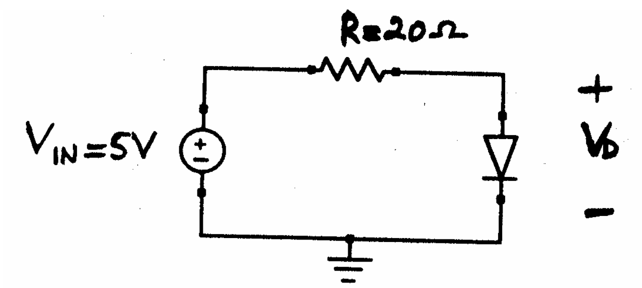


(d) Compare the two values of V_x which you calculated in (b) and (c) above and explain, in detail, why these values are equal, or different, depending on your findings.

2. An experimental diode has been found, in the laboratory, to exhibit I_D-V_D characteristics described by the following relationships:

$$I\_D = \begin{cases} 0 & \text{for } V\_D < 2.1\text{V} \\ m * (V\_D - 2.1 \text{ Volt}) & \text{for } V\_D \geq 2.1 \text{ V, and } m = 0.15 \text{ A/V} \end{cases}$$

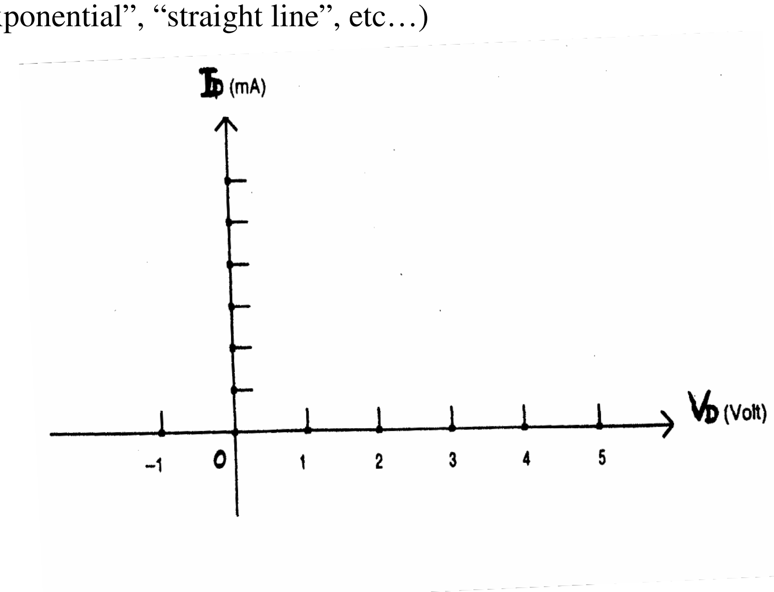
This diode is connected in the circuit shown below:



(a) Draw: the I_D-V_D characteristics of this diode for -1V ≤ V_D ≤ +5V, as accurately as possible on the set of axes provided below.

Indicate numerical values on the I_D axis [note that the I_D scale is in mA].

Identiify, in writing, the shape of any curve you draw, or portion thereof, (e.g. "exponential", "straight line", etc…)

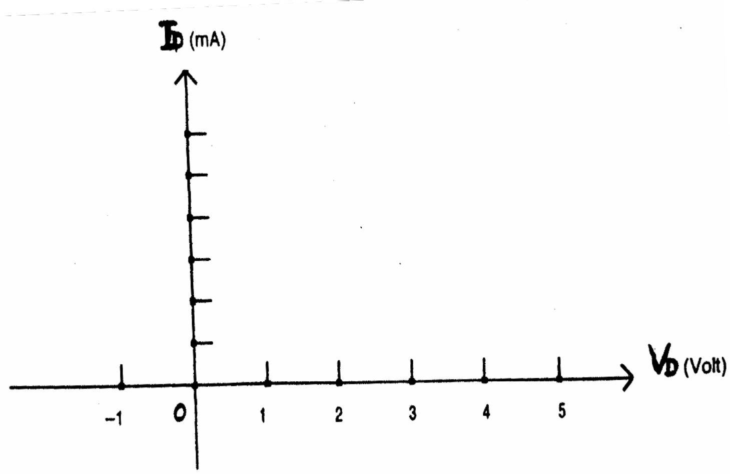


2. (Continued)

(b) Determine the “load line” (I-V characteristics) of the linear part of the circuit.

Explain your method clearly and show all details of your procedure. DO NOT DRAW THIS LOAD LINE in the space immediately below; a set of axes is provided for this purpose at the bottom of this page.

On the set of axes provided below:
Draw the “load line” (I-V characteristics) of the linear part of the circuit, as accurately as possible, and superimpose it on (i.e. re-draw) the I_D-V_D characteristics of part (a).



(c) Determine the numerical values of the coordinates of the intersection point(s) of the two curves superimposed in (b), and explain what the intersection point(s) represent(s).

2. (Continued)

(d) Solve, analytically and explicitly, for the diode voltage V_D in the circuit in terms of the symbolic parameters V_in, m, and R only. DO NOT PLUG IN NUMBERS for V_in, m, and R.

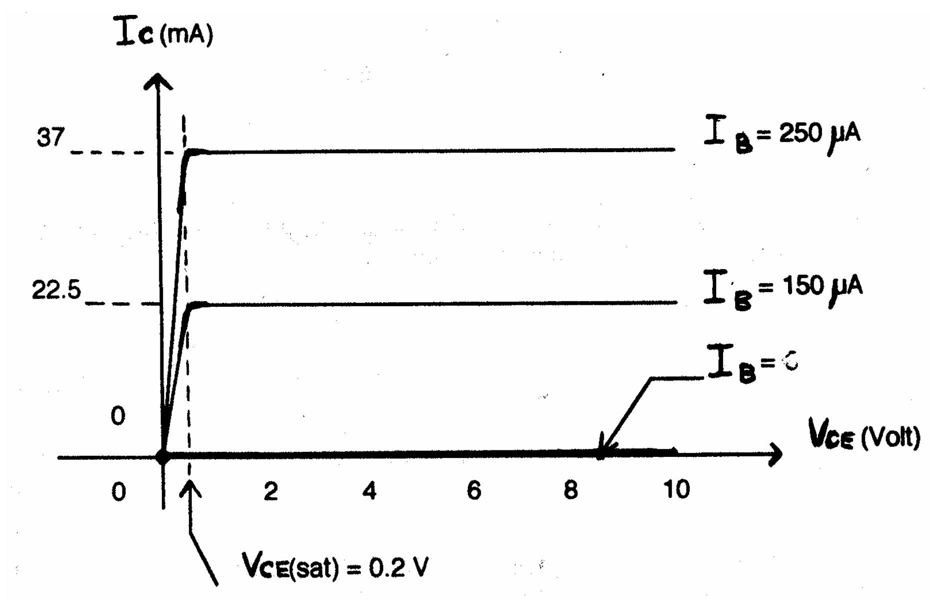
(e) Find the numerical value of the diode voltage, V_D*, (in Volt) in this circuit to three (3) decimal places if (V_in = 5V, m = 0.15 A/V, and R = 20 ohms, using your result for (d).

(f) Find the numerical value of the diode current, I_D*, (in Ampere) in this circuit to three (3) decimal places, using your results for (d) and (e).

(g) Compare your numerical results of (e) and (f) to those of (c).
Quantify the extent (e.g. percentage) to which these results differ, and
Explain, clearly and carefully, whether this is expected and why.

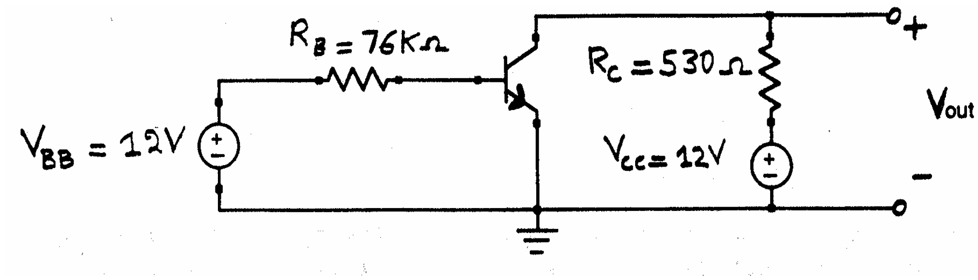
3. (a) Define, mathematically and in words, the parameter "beta" of an npn Bipolar Junction Transistor and state any restrictions on the validity of this definition.

(b) For the npn BJT whose I-V characteristics are shown below, determine the numerical value of beta at V_CE = 5V for each of the three (3) given curves and identify, by name, the BJT's region of operation at each of these three operating points.



3. (Continued)

The BJT whose I-V characteristics are shown in (b) above is used in the following circuit.



(c) Assuming V_BE = 0.6V and a Forward Active BJT, find the numerical value of V_out (in Volt).

(d) Use your numerical result for V_out in (c) to determine (i.e. name) the region of operation of the BJT in this circuit. Justify your answer carefully.

(e) Find the numerical value of the total power (in Wattt) dissipated by the BJT, if it is known that the emitter current of the transistor is I_E = 22.7 mA.