

EECS 105 Prof. Neureuther Spring 2001 MT2

I. (30 Points) Diode and Bipolar Device Physics

An npn transistor is designed to have a forward active β_F of 100 and a transit time of 50 ps. For each of the following, find the fractional change in the electrical device parameter of the transistor as produced by the change of the physical structure or operating conditions. Briefly explain the physical mechanism by which the electrical parameter changes.

- 1) The change in β_F when the width of the base is doubled.

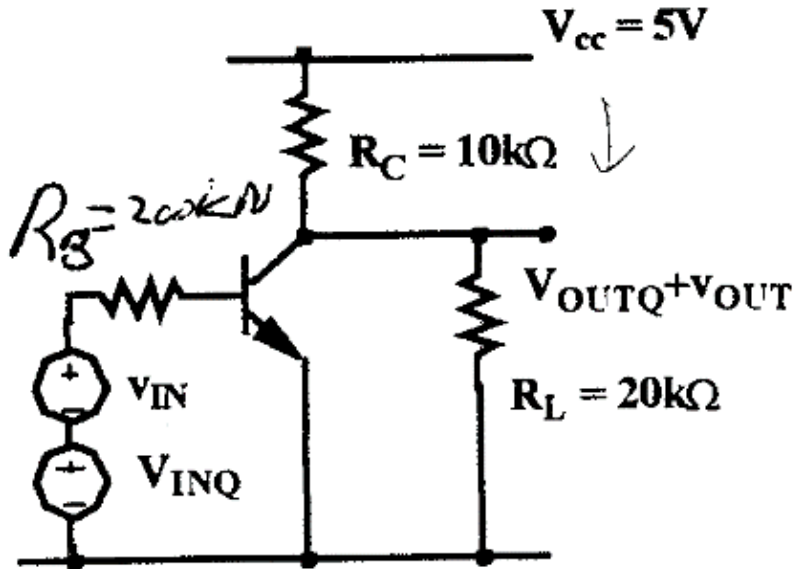
- 2) The change in β_F when the diffusivity of holes is doubled everywhere.

- 3) The change in V_{BE} required to double the current.

- 4) The change in the amount and spatial distribution of the minority charge in the base when the base width is doubled and the forward current is constant.

II. (35 Points) Bipolar Circuits

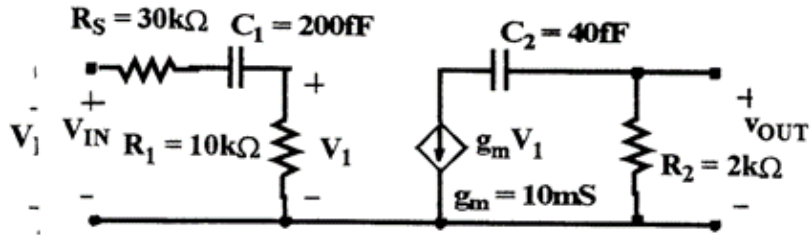
- a) (12 Points) Find the large-signal quantities V_{IN} and V_{OUT} when the transistor is in forward active and I_C is 100 μA .



- b) (13 Points) Find the small-signal model for the circuit and give values for elements associated with the transistor including the fact that V_A is not zero.
- c) (15 Points) Give a sufficient set of equations for determining the small-signal gain V_{OUT}/V_{IN} for the circuit in part b.

III. (35 Points) Frequency Response

- a) (15 Points) Derive an expression for the voltage transfer function v_{OUT}/v_{IN} .



- b) (10 Points) List all poles and zeros, give all transition frequencies and the asymptotic behavior as ω goes to zero and as ω goes to infinity.

- c) (10 Points) Using your data from part b complete a Bode plot of the magnitude and phase of the transfer function found in part a. Be sure to label the axes.

