國立臺灣大學 103 學年度碩士班招生考試試題

Multiple choice questions (20%)

1. Which of the following statements are right?
   (a) A conduction band means a set of available energy states for free electrons in free space;
   (b) The effective mass of a carrier can be estimated from its wave function;
   (c) The hole is the empty state providing a positive electronic charge. Therefore, it is boson particle;
   (d) The carrier concentration can be determined by the density of states and the Fermi-Dirac distribution function;
   (e) The intrinsic Fermi-level position of silicon must be at the center level of its bandgap.
2. Which of the following statements are right?
   (a) The completely ionized assumption of dopants is based on operating under the condition of room temperature;
   (b) If the doping concentration is similar as the intrinsic carrier concentration, the majority carrier concentration can be equal to the donor impurity concentration;
   (c) The drift current will usually be due to the majority carrier in an extrinsic semiconductor;
   (d) MOSFET is a device operated with majority carriers;
   (e) To have a strong diffusion current density, the doping concentration of a semiconductor should be as higher as possible.
3. Which of the following statements are right?
   (a) The excess carrier of a semiconductor can be introduced by magnetic field or force field;
   (b) At steady-state of a semiconductor, the generation rate is equal to the recombination rate;
   (c) In N-type semiconductor, the electron recombination rate is higher than the hole recombination rate;
   (d) In an extrinsic semiconductor, all the excess carriers move with a single effective mobility or diffusion coefficient;
   (e) The excess carriers recombine at the rate of the excess minority carrier lifetime.
4. For a semiconductor device, which of the following statements are right?
   (a) In reverse biased region, both junction capacitance and diffusion capacitance contribute to the small-signal equivalent model of a PN junction;
   (b) In a PN junction, the generation current is the dominant reverse-bias current;
   (c) The BJT current is major due to the carrier diffusion;
   (d) The cause of early voltage of both MOSFET and BJT are the same;
   (e) To have a good transconductance, in general, BJT is better than MOSFET

Short Answer Question

5. Please briefly explain the difference between Fermi-Dirac probability function and Maxwell-Boltzmann probability function. (4%)
6. Please schematically draw the current components in a BJT operating at forward-active region. (6%)

見背面

國立臺灣大學 103 學年度碩士班招生考試試題

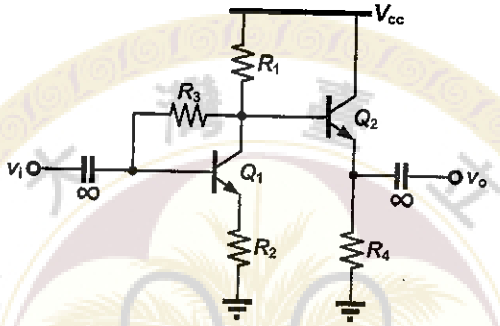
Calculations

7. The circuit parameters are given as:

V_{CC} = 20 V, R_1 = 10 kΩ, R_2 = 1 kΩ, R_3 = 200 kΩ, R_4 = 8 kΩ, and β = 50.

(a) Based on dc analysis, find the values of I_{C1} and I_{C2}. (10%)

(b) What is the small-signal gain of v_o/v_i? (10%)



8. An amplifier having a low-frequency gain of 10^3 and poles at 10^4 Hz and 10^6 Hz is operated in a closed negative-feedback loop with a frequency- independent β (feedback factor).

(a) For what value of β do the closed-loop poles become coincident? At what frequency? (10%)

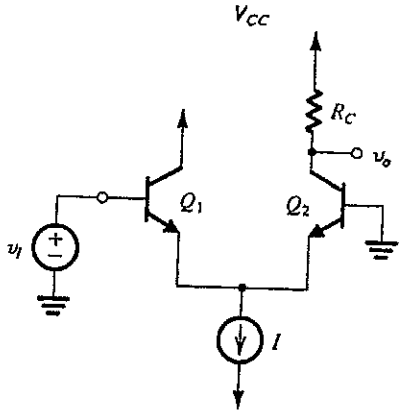
(b) What is the low-frequency gain corresponding to the situation in (a)? What is the value of the closed-loop gain at the frequency of the coincident poles? (10%)

(c) If β is increased by a factor of 10, what are the new pole locations? (10%)

9. Assume that the BJTs in the following circuit are matched and have a current gain α. Derive the expression for the small-signal voltage gain V_o/V_i of the circuit in two different ways:

(a) as a differential amplifier. (10%)

(b) as a cascade of a common-collector stage Q_1 and a common-base stage Q_2. (10%)



試題隨卷繳回