國立成功大學

110學年度碩士班招生考試試題

編　號： 156

系　所： 生物醫學工程學系

科　目： 電子學

日　期： 0202

節　次： 第 2 節

備　註： 可使用計算機

國立成功大學 110 學年度碩士班招生考試試題

系　所：生物醫學工程學系

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考試日期：0202，節次：2

第1頁，共3頁

※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. **(15%)** Please explain the following terminologies:

   a) Miller compensation, **b)** SRAM and DRAM, **c)** TTL logic, **d)** Transconductance, **e)** Mass action law

2. **(15%)** Please answer following questions for the circuit shown in Figure 1.

   i. **(5 pts)** Please derive the transfer function $V_{out}(s)/V_{in}(s)$.

   ii. **(5 pts)** Please represent the $V_{out}(t)$ in terms of R, C, and $V_{in}(t)$.

   iii. **(5 pts)** Please explain what kind of applications can be applied by the circuit shown in Figure 1.

3. **(5%)** Please derive the differential gain for the circuit shown in Figure 2.

4. **(10%)** The lattice structure of Germanium is the same as silicon (diamond structure), the atomic weight of Germanium is 72.59, and the lattice constant is 0.564 nm. Find the density (g/cm^3) (3%), atomic density (atoms/cm^3) (3%), and the spacing between nearest-neighbor atoms in Germanium (4%).

5. **(10%)** Use the equation (E1) to (E3) to show that an *npn* transistor operated in saturation region exhibits a collector-to-emitter voltage, V_{CEsat}, given by

$$V_{CEsat} = V_T ln\left[(\frac{I_{SC}}{I_S})\frac{1+\beta_{forced}}{1-\beta_{forced}/\beta}\right]$$

Use this relationship to evaluate V_{CEsat} for $\beta_{forced} = 50,\ 10, 5$, and 1 for a transistor with $\beta = 100$ and with a CBJ area 100 times that of the EBJ. Present your results in a table.

$$i_C = I_S e^{v_{BE}/V_T} - I_{SC} e^{v_{BC}/V_T} \quad \text{(E1)}$$

$$i_B = \frac{I_S}{\beta} e^{v_{BE}/V_T} + I_{SC} e^{v_{BC}/V_T} \quad \text{(E2)}$$

$$\beta_{\text{forced}} = \left.\frac{i_C}{i_B}\right|_{\text{saturation}} \leq \beta \quad \text{(E3)}$$

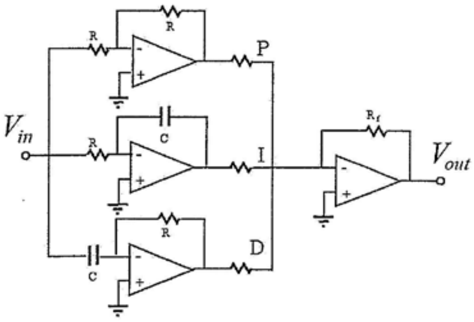

Figure 1

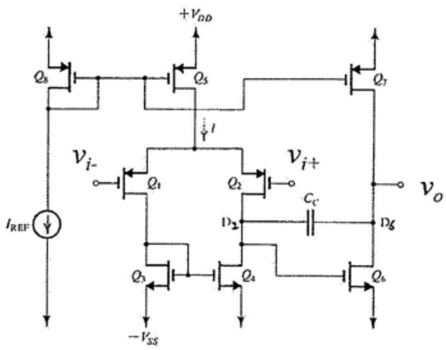

Figure 2

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6. **(10%)** Please find the output resistance of the double-cascode current mirror shown in Figure 3.
7. **(10%)** Find the voltages at all nodes and the currents through all branches in the circuit of Figure 4. Assume $|V_{BE}| = 0.7\text{ V}$ and $\beta = \infty$.

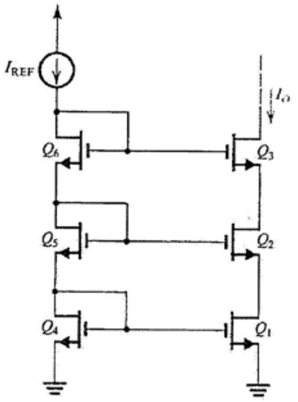

Figure 3

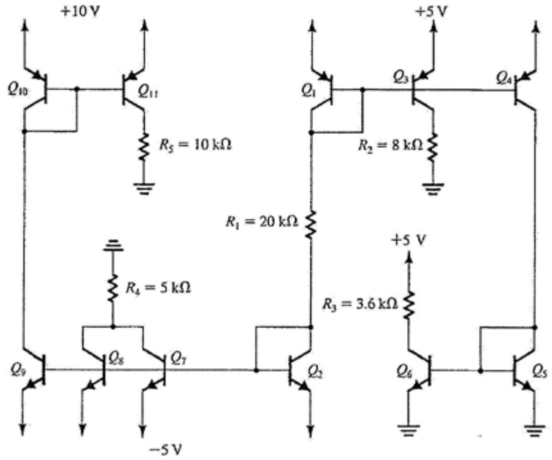

Figure 4

8. **(15%)** Please answer the following questions related to the emitter follower shown in Figure 5.
   - **i.** **(5 pts)** Please draw the high-frequency equivalent circuit of the emitter follower shown in Figure 5.
   - **ii.** **(10 pts)** Please derive the transfer function of the emitter follower shown in Figure 5.

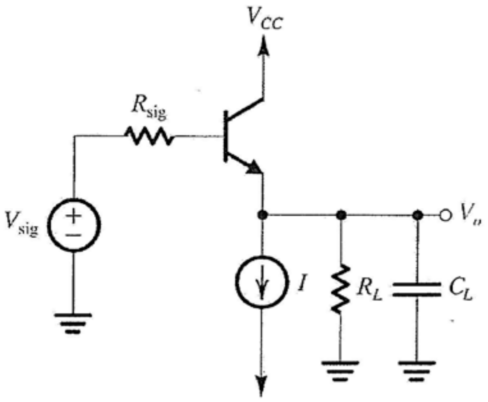

Figure 5

9. **(10%)** Figure 6 shows a discrete-circuit amplifier. The input signal v_{sig} is coupled to the gate through a very large capacitor (shown as infinite). The transistor source is connected to the ground at signal frequencies via a very large capacitor (shown as infinite). The output voltage signal that develops at the grain is coupled to a load resistance via a very large capacitor (shown as *infinite*). All capacitors behave as short circuits for signals and as open circuits for DC.

   i. **(2 pts)** It the transistor has $V_t = 1$ V, and $k_n = 4$ mA/V^2, verify that the bias circuit establishes $V_{GS} = 1.5$ V, $I_D = 0.5$mA, and $V_D = +0.7$ V. That is, assume these values, and verify that they are consistent with the values of the circuit components and the device parameters.

   ii. **(2 pts)** Find g_m and r_o if $V_A = 100$ V.

   iii. **(2 pts)** Draw a complete small-signal equivalent circuit for the amplifier, assuming all capacitors behave as short circuits as signal frequencies.

   iv. **(4 pts)** Find R_{in}, v_{gs}/v_{sig}, v_o/v_{gs}, and v_o/v_{sig}.

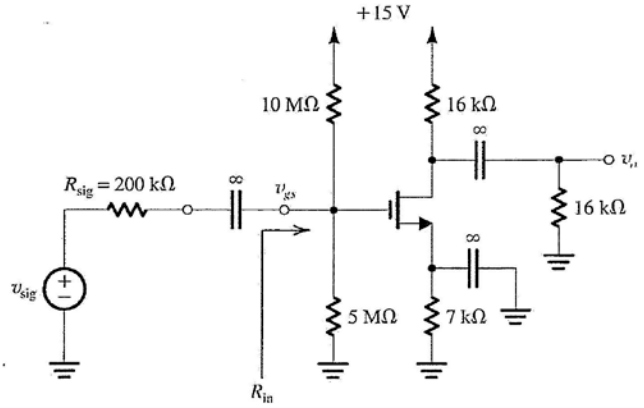

Figure 6