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1. In X-ray imaging system, the high voltage power supply is one of important components. Fig. 1 shows a circuit that may be extended to provide a dc voltage having higher multiples of input peak voltage. When excited by a sinusoid of amplitude V_p, and assuming ideal diodes, describe how this circuit works, and draw the waveform of the voltage across D_1. (20%)

2. For a *pn* junction in equilibrium at room temperature with the doping concentration $N_A=10^{18}/cm^3$ and $N_D=10^{16}/cm^3$, the cross-sectional area $A=10^{-4}$ cm^2, and the intrinsic carrier density $n_i=1.5x10^{10}/cm^3$, let the diffusion length of holes $L_p=5$ μm, the diffusion length of electrons $L_n=10$ μm, the diffusion constant of holes (in the *n* region) $D_p=10$ $cm^2/V.s$, the diffusion constant of electrons (in the *p* region) $D_n=18$ $cm^2/V.s$. If the *pn* junction is forward biased and conducting a current $I=0.1$ mA, calculate (a) the saturation current I_S, (b) the forward-bias voltage V, and (c) the component of the current I due to hole injection and that due to electron injection across the junction. (20%)

3. Fig 2 shows two circuits for generating a constant current $I_O=10$ μA under a 10 V voltage supply. Assuming that V_{BE} is 0.7 V at a current of 1 mA and neglecting the effect of finite β, determine the values of resistances for R_1, R_2, and R_3. (15%)

4. For a differential amplifier as shown in Fig. 3 and neglecting the transistor r_o, calculate the CMRR if there is a mismatch ΔR_C between the two collector resistances (i.e., Q_1 has R_C, and Q_2 has $R_C+\Delta R_C$). (15%)

5. A capacitively coupled amplifier has a midband gain of 100 V/V, a single high-frequency pole at 10 kHz, and a single low-frequency pole at 100 Hz. If negative feedback is employed so that the midband gain is reduced to 10, determine the upper and lower 3-dB frequencies of the closed-loop gain. (10%)

6. The Antoniou inductance-simulation circuit is often used to realize the second-order active filters. Design a bandpass filter using the Antoniou inductance-simulation circuit and derive its transfer function with the center-frequency gain *K*. (20%)

(背面仍有題目,請繼續作答)

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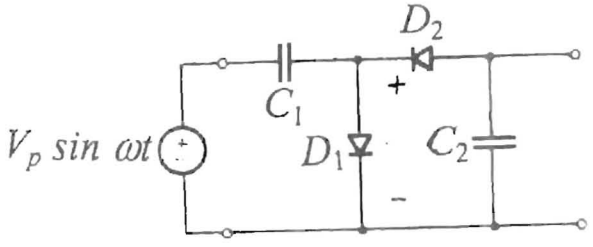

Fig. 1

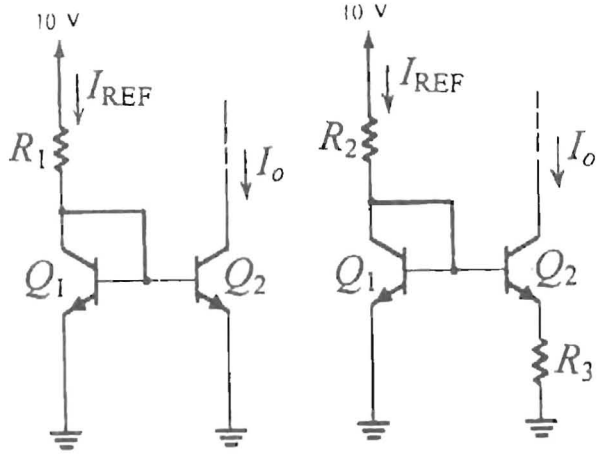

Fig. 2

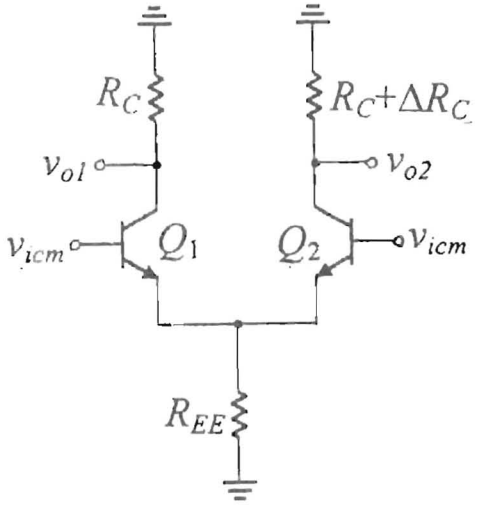

Fig. 3