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# 部分习题答案

## 第 1 章

- 1.2.1 (1)  $v(t) = 5\sin(2 \times 10^4 \pi t)$  (V); (2)  $v(t) = 220\sqrt{2}\sin(100\pi t)$  (V);  
(3)  $v(t) = 0.05\sin(2\,000\pi t)$  (V); (4)  $v(t) = 0.125\sin(1\,000t)$  (V);
- 1.2.2  $\frac{V_s^2}{4R}, \frac{2V_s^2}{\pi^2 R}, \frac{2V_s^2}{9\pi^2 R}, 95\%$
- 1.4.1 (1) 8.26; (2) 2.5; (3) 0.0826; (4) 0.826
- 1.5.1 200, 46 dB; 100, 40 dB; 20 000, 43 dB
- 1.5.2 250  $\Omega$
- 1.5.3 100  $\Omega$
- 1.5.4 800, 58 dB; 2 000, 66 dB;  $1.6 \times 10^6$ , 62 dB
- 1.5.6  $R_1/(\beta + 1)$
- 1.5.7 0.708

## 第 2 章

- 2.1.1 (1)  $\pm 10 \mu\text{V}$ ; (2)  $\pm 1 \times 10^{-8} \mu\text{A}$
- 2.1.2  $v_o$  不能小于  $-11 \text{ V}$
- 2.3.1 图 a 6 V; 图 b 6 V; 图 c +2 V; 图 d +2V
- 2.3.2 图 a  $v_o = 4 \text{ V}$ ,  $i_1 = i_2 = 0.33 \text{ mA}$ ,  $i_3 = i_4 = -0.2 \text{ mA}$ ,  $i_o = 1 \text{ mA}$ ; 图 b  $v_o = -150 \sin\omega t$  (mV),  $i_2 = i_1 = 10 \sin\omega t$  ( $\mu\text{A}$ ),  $i_o = -40 \sin\omega t$  ( $\mu\text{A}$ ); 图 c  $v_{o1} = -1.2 \text{ V}$ ,  $v_o = 1.8 \text{ V}$
- 2.3.3 (1)  $R_{1\min} = 8 \text{ k}\Omega$ ,  $R_{2\min} = 92 \text{ k}\Omega$ ; (2)  $R_1 = 50 \text{ k}\Omega$ ,  $R_2 = 400 \text{ k}\Omega$
- 2.3.5 (1)  $V_C = 6 \text{ V}$ ,  $V_B = 0 \text{ V}$ ,  $V_E = -0.7 \text{ V}$ ; (2)  $\beta = 50$
- 2.4.1  $\frac{R_2}{R_1} \left( \frac{-\delta}{4 + 2\delta} \right) v_i$

2.4.2  $-(R_2R_4/R_1R_3)$

2.4.3  $R_2 = 200 \text{ k}\Omega$ ,  $R_3 = R_4 = 51 \text{ k}\Omega$ ,  $R_p = 100 \text{ k}\Omega$ ,  $R_1 = R'_1 + R_p = (1 + 100) \text{ k}\Omega$

2.4.4  $R_5 = 280 \text{ k}\Omega$ ,  $R_1 = 40 \text{ k}\Omega$ ,  $R_2 = 20 \text{ k}\Omega$ ,  $R_3 = 80 \text{ k}\Omega$ ,  $R_4 = 28 \text{ k}\Omega$

2.4.5 (1)  $v_o = \left(1 + \frac{R_4}{R_3}\right) \left(\frac{1}{R_1 + R_2}\right) (R_2v_{i1} + R_1v_{i2})$ ,  $v_o = v_{i1} + v_{i2}$

(2)  $v_o = \frac{R_2R_3v_{i1} + R_1R_3v_{i2} + R_1R_2v_{i3}}{R_1R_2 + R_2R_3 + R_1R_3}$ ,  $v_o = \frac{1}{3}(v_{i1} + v_{i2} + v_{i3})$

2.4.6  $v_o = -(5/4)v_{i1} - 2v_{i2} + (51/22)v_{i3} + (51/44)v_{i4}$

2.4.7  $v_{o1} = -3 \text{ V}$ ,  $v_{o2} = 4 \text{ V}$ ,  $v_o = 5 \text{ V}$

2.4.8 (1)  $v_o = -5 \text{ V}$ ; (2)  $v_{o1}$ 的幅值  $-7.66 \text{ V}$ , 回零时间  $t = 120 \text{ ms}$

2.4.9 (1)  $v_{o1} = \left(\frac{R_3}{R_2 + R_3}\right) \left(1 + \frac{R_4}{R_1}\right) v_{i2} - \frac{R_4}{R_1} v_{i1}$ ,  $v_o = -\frac{1}{C} \int_0^t \left(\frac{v_{o1}}{R_5} + \frac{v_{i3}}{R_6}\right) dt$

(2)  $v_o = -\frac{1}{RC} \int_0^t [(v_{i2} - v_{i1}) + v_{i3}] dt$

2.4.10 (1)  $v'_o = \frac{1}{RC} \int_0^t v_{i2} dt$ ; (2)  $v''_o = -\frac{1}{RC} \int_0^t v_{i1} dt$ ; (3)  $v_o = \frac{1}{RC} \int_0^t (v_{i2} - v_{i1}) dt$

2.4.11  $v_o$ 的幅值为  $\pm 0.1 \text{ V}$

2.4.12 (1)  $\frac{V_o(s)}{V_i(s)} = -\frac{sR_2C_1}{(1 + sR_1C_1)(1 + sR_2C_2)}$ ; (2)  $f \ll f_H = \frac{1}{2\pi RC}$

2.4.13 (1)  $A_v(s) = -\left(\frac{R_2}{R_1} + \frac{1}{sR_1C}\right)$

2.4.14 (1)  $v_{o1} = +0.3 \text{ V}$ ,  $v_{o2} = -\frac{1}{10s} \int_0^t v_{i2} dt$ ,  $v_o = -0.3 \text{ V} + \frac{1}{10s} \int_0^t v_{i2} dt$

### 第3章

3.2.1  $0.34 \text{ V}$

3.4.3 (1)  $8.6 \text{ mA}$ ,  $1.4 \text{ V}$ ; (2)  $1.406 \text{ V} \sim 1.394 \text{ V}$

3.4.4  $1.393 \sim 1.407 \text{ V}$

3.4.5  $-6 \text{ V}$ ,  $-12 \text{ V}$ ,  $0 \text{ V}$ ,  $-6 \text{ V}$

3.4.6 (a) 截止; (b) 截止; (c) 导通

3.4.10 (1)  $1.3 \text{ mA}$ ,  $1.3 \text{ V}$ ; (2)  $49 \mu\text{A}$ ,  $49 \text{ mV}$ ; (3)  $1.3 + 0.049 \sin(2\pi \times 50t) (\text{V})$

3.5.2 (1)  $V_z \left(\frac{V_1 - V_z}{R} - \frac{V_z}{R_L}\right)$ ; (2)  $\frac{V_z^2}{R_L}$ ,  $\frac{(V_1 - V_z)^2}{R}$

3.5.3 (1) 大于  $111 \Omega$ ; (2)  $225 \text{ mW}$ ; (3)  $250 \text{ mW}$ ,  $250 \text{ mW}$

SP3.6.1  $0.34 \text{ V}$

SP3.6.2  $62.56$

SP3.6.4 小于  $170 \text{ mA}$

### 第4章

4.1.1 A - c、B - e、C - b; PNP 管

- 4.1.2 A-c、B-b、C-e; NPN管;  $\bar{\beta} = 50$
- 4.1.3  $I_C = 15 \text{ mA}$ ; 电压为 30 V
- 4.2.1 (a) 无; (b) 有; (c) 无; (d) 无
- 4.2.2 S→A: 饱和区;  $I_C = 3 \text{ mA}$   
S→B: 放大区;  $I_C = 1.92 \text{ mA}$   
S→C: 截止区;  $I_C = 0$
- 4.2.3 (a) 放大区; (b) 放大区; (c) 饱和区; (d) 截止区; (e) 饱和区
- 4.3.1  $\beta = 200$ ;  $V_{CES} = 0.8 \text{ V}$
- 4.3.2  $I_{CQ} = 4 \text{ mA}$ ,  $V_{CEQ} = 9 \text{ V}$
- 4.3.3  $I_{BQ} = 0.03 \text{ mA}$ ,  $I_{CQ} = 6 \text{ mA}$ ,  $V_{CEQ} = 6 \text{ V}$
- 4.3.4  $I_{BQ} = 0.125 \text{ mA}$ ,  $I_{CQ} = 25 \text{ mA}$ ,  $V_{CEQ} = 1 \text{ V}$
- 4.3.5 (1)  $V_{CC} = 6 \text{ V}$ ,  $I_{BQ} = 20 \mu\text{A}$ ,  $I_{CQ} = 1 \text{ mA}$ ,  $V_{CEQ} = 3 \text{ V}$   
(2)  $R_b = 300 \text{ k}\Omega$ ,  $R_c = 3 \text{ k}\Omega$   
(3)  $V_{om} = 1.5 \text{ V}$   
(4)  $i_{bm} = 20 \mu\text{A}$
- 4.3.6 设 BJT 为硅管, 在放大区时应有  $|v_{CE}| \geq 1 \text{ V}$ ,  $|v_{BE}| = 0.7 \text{ V}$ , 故应该使  $v_B = (v_E - 0.7) \text{ V}$ , 其中  $v_E \geq -2.67 \text{ V}$
- 4.3.7 因为  $\beta = 100 \gg 1$ , 故有  $i_E \approx i_C$ , 依题意  $R_e \approx 0.83R_c$
- 4.3.9 (1)  $I_{BQ} = 40 \mu\text{A}$ ,  $I_{CQ} = 2 \text{ mA}$ ,  $V_{CEQ} = 4 \text{ V}$   
(3)  $r_{be} = 863 \Omega$   
(4)  $A_v \approx -116$ ,  $A_{vs} \approx -73$
- 4.3.10  $R_b = 240 \text{ k}\Omega$ ,  $R_c \geq 3.75 \text{ k}\Omega$ ,  $V_{CEQ} = 8.25 \text{ V}$
- 4.3.11 (1)  $I_{BQ} = 40 \mu\text{A}$ ,  $I_{CQ} = 4 \text{ mA}$ ,  $V_{CEQ} = -4 \text{ V}$   
(2)  $A_v \approx -155.6$ ,  $R_i \approx 0.86 \text{ k}\Omega$ ,  $R_o \approx 2 \text{ k}\Omega$   
(4) 截止失真; 减小  $R_b$
- 4.3.12 (1)  $I_{CQ} \approx \beta V_{CC} / R_1$ ,  $V_{CEQ} = V_{CC} - I_{CQ}(R_2 + R_3)$   
(2)  $A_v = -\beta(R_2 \parallel R_L) / r_{be}$ ,  $R_i = R_1 \parallel r_{be}$ ,  $R_o \approx R_2$   
(3) 使  $|A_v|$  增加,  $R_o$  增大
- 4.4.1 (1)  $I_{BQ} \approx 15 \mu\text{A}$ ,  $I_{CQ} = 0.9 \text{ mA}$ ,  $V_{CEQ} = 5.88 \text{ V}$   
(2)  $\beta = 75$ ,  $V_{BEQ} = 0.6 \text{ V}$ ,  $I_{BQ} \approx 15.2 \mu\text{A}$ ,  $I_{CQ} = 1.14 \text{ mA}$ ,  $V_{CEQ} \approx 4.25 \text{ V}$   
(3)  $I_{BQ} \approx 15 \mu\text{A}$ ,  $I_{CQ} = 1.73 \text{ mA}$ ,  $V_{CEQ} = 0.24 \text{ V}$ , BJT 进入饱和区
- 4.4.2 图(a)能; 图(b)不能
- 4.4.3 (1)  $I_{BQ} \approx 28 \mu\text{A}$ ,  $I_{CQ} = 1.65 \text{ mA}$ ,  $V_{CEQ} = 7.8 \text{ V}$   
(2)  $r_{be} \approx 1.2 \text{ k}\Omega$   
(3)  $A_v \approx -100$   
(4)  $R_{bi} \approx 38.2 \text{ k}\Omega$
- 4.4.4 (2)  $R_i \approx 4.6 \text{ k}\Omega$ ,  $R_o \approx 3.3 \text{ k}\Omega$ ; (3)  $v_o \approx -124.5 \text{ mV}$
- 4.4.5 (1)  $R_e = 14.3 \text{ k}\Omega$ ; (2)  $R_c = 10 \text{ k}\Omega$ ; (3)  $A_{vs} \approx -100$

- 4.4.6 (1)  $I_{BQ} \approx 12.7 \mu\text{A}$ ,  $I_{CQ} \approx 1.27 \text{ mA}$ ,  $V_{CEQ} \approx 4.4 \text{ V}$   
 (2)  $A_v \approx -27.2$ ,  $R_i \approx 15.55 \text{ k}\Omega$ ,  $R_o \approx 10 \text{ k}\Omega$
- 4.5.1 共集电极组态;  $v_o$  波形有错
- 4.5.2 (1)  $I_{BQ} \approx 23 \mu\text{A}$ ,  $I_{CQ} = 1.15 \text{ mA}$ ,  $V_{CEQ} = -6.13 \text{ V}$   
 (2)  $A_v \approx 0.99$ ,  $R_i \approx 87.3 \text{ k}\Omega$ ,  $R_o = 36 \Omega$   
 (3)  $v_o \approx 197 \text{ mV}$
- 4.5.3 (1)  $I_{BQ} \approx 18 \mu\text{A}$ ,  $I_{CQ} = 1.8 \text{ mA}$ ,  $V_{CEQ} = 2.8 \text{ V}$   
 (2)  $A_{v1} \approx -0.79$ ,  $A_{v2} \approx 0.8$   
 (3)  $R_i \approx 8.2 \text{ k}\Omega$   
 (4)  $R_{o1} \approx 2 \text{ k}\Omega$ ,  $R_{o2} \approx 31 \Omega$
- 4.5.4  $A_v \approx 268$ ,  $R_i \approx 28 \Omega$ ,  $R_o \approx 7.5 \text{ k}\Omega$
- 4.5.5 ①  $A_v = -\beta R_c / [r_{be} + (1 + \beta) R_e]$ ,  $R_i = r_{be} + (1 + \beta) R_e$ ,  $R_o \approx R_c$   
 ②  $A_v = \beta R_c / [r_{be} + (1 + \beta) R_e]$ ,  $R_i = R_e + r_{be} / (1 + \beta)$ ,  $R_o \approx R_c$   
 ③  $A_v = (1 + \beta) R_e / [r_{be} + (1 + \beta) R_e]$ ,  $R_i = r_{be} + (1 + \beta) R_e$ ,  $R_o = R_e \parallel [r_{be} / (1 + \beta)]$
- 4.5.6 (1)  $V_{BQ} = -0.1 \text{ V}$ ,  $V_{EQ} = -0.8 \text{ V}$ ,  $V_{CQ} = 2 \text{ V}$   
 (2)  $r_{be} \approx 2.83 \text{ k}\Omega$   
 (3)  $A_{vs} \approx -28.42$   
 (4)  $A_{vs} \approx 19.47$   
 (5)  $A_{vs} \approx 0.08$
- 4.6.1 (1)  $I_{CQ1} \approx I_{CQ2} \approx 10.2 \text{ mA}$ ,  $V_{CEQ1} = 6 \text{ V}$ ,  $V_{CEQ2} = 4.9 \text{ V}$   
 (2)  $A_{v1} \approx -1$ ,  $A_{v2} \approx 102$ ,  $A_v = -102$ ,  $R_i \approx r_{be1} = 0.46 \text{ k}\Omega$ ,  $R_o \approx R_{c2} = 0.47 \text{ k}\Omega$
- 4.6.2 (1)  $I_{BQ1} \approx 1.04 \mu\text{A}$ ,  $I_{CQ1} \approx 1.04 \text{ mA}$ ,  $V_{CEQ1} \approx 7.6 \text{ V}$   
 $I_{BQ2} \approx 27 \mu\text{A}$ ,  $I_{CQ2} \approx 2.7 \text{ mA}$ ,  $V_{CEQ2} \approx 6 \text{ V}$   
 (2)  $A_v \approx -182$ ,  $R_i \approx 1.88 \text{ k}\Omega$ ,  $R_o \approx 61 \Omega$
- 4.6.3 (1) CC - CB 组态  
 (2)  $I_{CQ1} \approx I_{CQ2} \approx 1.33 \text{ mA}$ ,  $V_{CEQ1} = 6.7 \text{ V}$ ,  $V_{CEQ2} \approx 3.8 \text{ V}$   
 (3)  $R_i \approx 2.4 \text{ k}\Omega$ ,  $A_v = 0.5$ ,  $A_{v1} = 46$ ,  $R_o \approx R_{c2} = 2.2 \text{ k}\Omega$
- 4.7.1 (1)  $|\dot{A}_{VM}| = 1000$ ,  $f_L = 100 \text{ Hz}$ ,  $f_H = 100 \text{ MHz}$   
 (2)  $|\dot{A}_v| (\text{dB}) = 57 \text{ dB}$
- 4.7.2  $f_H = 100 \text{ kHz}$ ,  $f_L = 10 \text{ Hz}$ ,  $|\dot{A}_{VM}| (\text{dB}) = 40 \text{ dB}$ , 相位差为  $0^\circ$
- 4.7.3  $|\dot{A}_M| = 10$ ,  $f_L = 10 \text{ Hz}$ ,  $f_H = 1 \text{ MHz}$ ,  $|\dot{A}| = 1$  时,  $f$  为  $1 \text{ Hz}$  或  $10 \text{ MHz}$
- 4.7.4 (1) 不会失真,  $V_{om} = 1 \text{ V}$ , 相位差为  $-180^\circ$   
 (2) 此时  $f = f_H$ , 不会失真,  $V_{om} = 2.83 \text{ V}$ , 相位差为  $-225^\circ$   
 (3) 此时  $f = 100 \text{ kHz}$ , 超出通带, 但输出波形仍不会失真
- 4.7.5 (1)  $f_L = 392 \text{ Hz}$ ; (2)  $V_{om} = 818 \text{ mV}$ , 相位差为  $-135^\circ$
- 4.7.6  $g_m \approx 57.69 \text{ mS}$ ,  $C_{b'e} = 92 \text{ pF}$ ,  $r_{b'e} \approx 866.7 \Omega$ ,  $r_{bb'} = 233.3 \Omega$
- 4.7.7 (a)  $f_H \approx 3.13 \text{ MHz}$



(b) 中频电压增益变化约 1.42 倍, 上限频率变化约 0.78 倍, 增益-带宽积变化约 1.11 倍

4.7.8 (1)  $R_i \approx 5.55 \text{ k}\Omega$ ; (2)  $|\dot{A}_{VM}| \approx 30.64$ ; (3)  $f_H \approx 1.72 \text{ MHz}$

4.7.9  $f_L \approx 143 \text{ Hz}$

4.8.1 (1)  $t_r = 0.0044 \mu\text{s}$ ; (2)  $t_r = 0.035 \mu\text{s}$ ; (3)  $t_r = 0.35 \mu\text{s}$

4.8.2 (1) 平顶降落为 4.16%; (2)  $f_{\min} = 416 \text{ Hz}$

SP4.9.1 (3)  $R_i \approx 743 \Omega$ ,  $R_o \approx 3.12 \text{ k}\Omega$

SP4.9.3  $f_L \approx 10 \text{ Hz}$ ,  $f_H \approx 99.7 \text{ kHz}$ ,  $20\lg A_{VM} = 24 \text{ dB}$ , 中频段相位差约为  $0^\circ$

## 第 5 章

5.1.1 图 a: N 沟道耗尽型,  $V_P = -3 \text{ V}$ ; 图 b: P 沟道耗尽型,  $V_P = 2 \text{ V}$ ; 图 c: P 沟道增强型,  $V_T = -4 \text{ V}$

5.1.2 (1) 增强型; (2) P 沟道; (3)  $V_T = -4 \text{ V}$

5.1.3  $v_{GS} = -1.08 \text{ V}$ ,  $v_{DS} = -1.58 \text{ V}$

5.1.4  $I_D = 0.499 \text{ mA}$

5.2.1  $V_{GS} = 2 \text{ V}$ ,  $I_D = 0.1 \text{ mA}$ ,  $V_{DS} = 2 \text{ V}$

5.2.2  $I_D = -0.45 \text{ mA}$ ,  $V_{DS} = -1.625 \text{ V}$

5.2.3  $A_v \approx -8.24$ ,  $A_{vs} \approx -8.1$

5.2.4  $A_v \approx -12.78$

5.2.5  $R_i = 120 \text{ k}\Omega$ ,  $A_{vs} = 0.86$ ,  $R_o \approx 80 \Omega$

5.2.6  $A_v = -200$

5.2.7  $A_v = -175$

5.2.8  $A_v = -5$

5.2.9 (2)  $\dot{A}_v = -3.3$ ; (3)  $R_i \approx 2075 \text{ k}\Omega$

5.3.3 N 沟道 JFET,  $V_P = -4 \text{ V}$ ,  $I_{DSS} = 3 \text{ mA}$

5.3.5 图 a: P 沟道, JFET; 图 b: N 沟道, 耗尽型 MOSFET; 图 c: P 沟道, 耗尽型 MOSFET; 图 d: N 沟道, 增强型 MOSFET

5.3.6 (1) 用图解法得,  $V_{GSQ} \approx -0.35 \text{ V}$ ,  $I_{DQ} \approx 0.22 \text{ mA}$ ,  $V_{DSQ} \approx 9.5 \text{ V}$

(2) 用计算得,  $V_{GSQ} \approx -0.33 \text{ V}$ ,  $I_{DQ} \approx 0.22 \text{ mA}$ ,  $V_{DSQ} \approx 9.2 \text{ V}$

5.3.7 (1)  $I_{DQ} = 1 \text{ mA}$ ,  $R_1 = 2 \text{ k}\Omega$ ; (2)  $R_{2\max} = 6 \text{ k}\Omega$ ; (3)  $\dot{A}_v \approx -1.1$  (忽略  $R_g$  影响),  $R_o \approx R_d = 10 \text{ k}\Omega$

5.3.8  $A_v \approx 0.92$ ,  $R_i \approx 2075 \text{ k}\Omega$ ;  $R_o \approx 1.02 \text{ k}\Omega$

5.5.1  $A_v \approx 0.89$ ,  $R_i \approx 5.1 \text{ M}\Omega$

5.5.4  $T_1$ ——共漏,  $T_2$ ——共射,  $A_{v1} \approx \frac{g_m r_{be}}{1 + g_m r_{be}}$ ,  $A_{v2} \approx \frac{-\beta(R_C \parallel R_L)}{r_{be}}$

$A_v \approx A_{v1} A_{v2}$ ,  $R_i \approx R_g$ ,  $R_o = R_C$

SP5.6.1 (1) 约为  $0.2 \text{ mA}$ ; (2) 约为  $1.3753 \text{ V}$ ; (3)  $-169.5$  倍

SP5.6.2 (1)  $I_D = 1.02 \text{ mA}$ ,  $V_{GS} = -1.09 \text{ V}$ ,  $V_{DS} = 7.73 \text{ V}$

(3)  $BW \approx 10.45 \text{ MHz}$ ,  $R_i \approx 2 \text{ M}\Omega$ ,  $R_o \approx 1.958 \text{ k}\Omega$

SP5.6.3 (1)  $I_D = 0.299 \text{ mA}$ ,  $V_{GS} = -2.52 \text{ V}$ ,  $V_{DS} = 7.72 \text{ V}$

## 第 6 章

6.1.1  $I_O = 19.4 \text{ mA}$

6.1.2  $r_o = r_{ce2}(1 + \beta_2)$

6.1.3  $R = 2.21 \text{ k}\Omega$ ,  $I_3 = 1 \text{ mA}$ ,  $I_4 = 0.5 \text{ mA}$

6.1.4  $A_v = -200$

6.1.5  $I_{REF} = 1.35 \text{ mA}$ ,  $I = 4.05 \text{ mA}$

6.2.1 (1)  $I_{C1} = I_{C2} = 0.5 \text{ mA}$ ,  $V_{CE1} = V_{CE2} = 5.7 \text{ V}$

(2)  $A_{vd} = -188.7$ ,  $A_{vd1} = -94.35$ ,  $A_{vc1} = -0.2$ ,  $K_{CMR1} = 471.75$

6.2.2 (1)  $v_o = -0.87 \text{ V}$ ; (2)  $v'_o = -0.29 \text{ V}$ ; (3)  $v_{o2} = 0.43$ ,  $A_{vd2} = 21.7$ ,  $A_{vc2} = -0.028$ ,  $K_{CMR2} \approx 775$ ; (4)  $R_{id} = 25.8 \text{ k}\Omega$ ,  $R_{ic} = 10.1 \text{ M}\Omega$ ,  $R_{o2} = 5.6 \text{ k}\Omega$

6.2.3  $R_{id} = 660.7 \text{ k}\Omega$ ,  $A_{vd1} = -28$ ,  $A_{vc1} = -0.63$ ,  $K_{CMR1} = 44.4$

6.2.4  $A_{vd2} = 12$ ,  $A_{vc2} = -0.0005$ ,  $K_{CMR2} = 24000$ ,  $R_{id} = 13.5 \text{ k}\Omega$ ,  $R_o = 4.7 \text{ k}\Omega$

6.2.5 (1)  $I_C = 0.52 \text{ mA}$ ,  $I_B = 10 \mu\text{A}$ ,  $V_{CE} = 4 \text{ V}$

(2)  $v_{id} = 0.061 \text{ V}$ ,  $v_{s1} = 0.0305 \text{ V}$ ,  $v_{s2} = -0.0305 \text{ V}$

6.2.6 (1)  $I_{REF} = 2.4 \text{ mA}$ ,  $I_O = 1.2 \text{ mA}$ ,  $I_{C1} = I_{C2} = 0.6 \text{ mA}$

(2)  $A_{vd2} = 1823$ ,  $A_{vc2} = 0.163$ ,  $K_{CMR2} = 11.18 \times 10^3$

(3)  $R_{id} = 9.8 \text{ k}\Omega$ ,  $R_{o2} = 83.5 \text{ k}\Omega$

6.2.7  $A_{vd2} = 112$

6.2.8 (1)  $I_{REF} = I_O = 10 \mu\text{A}$ ,  $I_{D1} = I_{D2} = 5 \mu\text{A}$

(2)  $v_{o2} = 600 \mu\text{V}$ ,  $A_{vd2} = 60$ ,  $A_{vc2} = -0.1$ ,  $K_{CMR2} = 600$

6.2.10 (1)  $A_{vd2} = 14.1$ ,  $A_{vc2} = -4.7 \times 10^{-3}$ ,  $K_{CMR2} = 3000$ ; (2)  $v_{O2} = 563.86 \text{ mV}$

6.2.11  $A_{vd2} = 35.258$ ,  $v_{O2} = 1410 \text{ mV}$ ,  $A_{vc2} = -6.25 \times 10^{-3}$ ,  $K_{CMR2} = 5.64 \times 10^3$

6.3.2  $v_{O1}$  和  $v_{O2}$  的幅值范围为  $9.1 \text{ V}$ ,  $v_o = v_{O1} - v_{O2}$  的幅值为  $9.1 \text{ V}$

6.5.1  $R_2 = 93.75 \text{ k}\Omega$

6.5.2 (1)  $V_o = -100 \text{ mV}$ ; (2)  $R_2 = 90.9 \text{ k}\Omega$ ; (3)  $V_o = -20 \text{ mV}$ ; (4)  $V_o = \pm 55 \text{ mV}$ ;  
(5)  $V_o = (-20 \pm 55) \text{ mV}$

6.5.3  $I_C = 20.7 \text{ nA}$

6.5.4  $f_H = 100 \text{ kHz}$ ,  $BW_P = 15.9 \text{ kHz}$

6.5.5 (1)  $V_{or} = 5.506 \text{ V}$ ; (2)  $V_{or} = 505 \text{ mV}$ ; (3)  $T = 94.3 \text{ }^\circ\text{C}$

6.6.2 
$$v_o = \sqrt[3]{\frac{-v_i}{K^2}}$$

6.6.3 (1)  $v_{O1} = Kv_{s1}^2$ ,  $v_{O2} = Kv_{s2}^2$ ,  $v_o = -K(v_{s1}^2 + v_{s2}^2)$ ; (2)  $v_o = -Kv_{sm}^2$

6.6.4 
$$A_{vf}(s) = -\frac{R_2}{R_1} \cdot \frac{1}{1 + \frac{sR_2C}{KV_C}}$$
,  $f_c = \frac{KV_C}{2\pi R_2C}$ ,  $f_0 = 39.8 \text{ Hz} \sim 79.6 \text{ Hz}$

SP6.8.1 (2)  $-123.2$ ,  $-0.0323$ ,  $3814.24$

SP6.8.2 (1)  $I_{REF} = 12.08 \mu\text{A}$ ,  $I_O = 11.41 \mu\text{A}$ ,  $I_{D1} = I_{D2} = 5.71 \mu\text{A}$ ,  $V_{D1} = V_{D2} = 2.338 \text{ V}$   
(2)  $51.87$ ,  $-0.009136$

## 第7章

7.2.3 (2)  $i_o \approx -v_i/R_3$ ; (3) 压控电流源

7.3.1  $v_i = 0.1 \text{ V}$ ,  $v_f = 0.099 \text{ V}$ ,  $v_{id} = 0.001 \text{ V}$

7.3.2  $A_1 A_2 / (1 + A_1 A_2 F_1 + A_2 F_2)$

7.3.3  $F_v = 0.098$ ,  $A_{vf} \approx 10.2$

7.4.1  $0.05\%$

7.5.1  $A_{vf} \approx 1 + R_f/R_{b2}$

7.5.2 (a)  $A_{vf} \approx -R_2$ ,  $A_{vf} \approx -R_2/R_1$

(b)  $A_{gf} \approx 1/R_{c1}$ ,  $A_{vf} \approx -(R_{c3} \parallel R_{c2})/R_{c1}$

(c)  $A_{if} \approx 1 + R_f/R_{c2}$ ,  $A_{gf} \approx R_{c2}(R_f + R_{c2})/R_s R_{c2}$

(d)  $A_{vf} \approx 1 + R_2/R_1$

7.5.3  $A_{vf} \approx -[R_{c4}(R_{c2} + R'_{c4}) + R_{c2}R'_{c4}]/R'_{c4}$

7.7.1  $8 \text{ kHz}$

7.7.2 带宽为  $50 \text{ kHz}$ , 增益-带宽积为  $5 \text{ MHz}$

7.8.1 (2)  $20 \lg |A_{VM} F_v|_{\max} = 18 \text{ dB}$ ; (3) 不能稳定工作

7.8.2  $F_v$  的变化范围是  $10^{-4} \sim 10^{-5}$ ; 环路增益的最大值是  $20 \text{ dB}$

\*7.8.3  $F_v = 0.02 \sim 0.00001$ , 环路增益约为  $1995.3$

SP7.9.1  $A_{vf} = 6$ ,  $R_{if} = 1.664 \times 10^{10} \Omega$ ,  $R_{of} = 0.00605 \Omega$

SP7.9.2  $A_{gf} = 82.53 \text{ mS}$ ,  $R_{if} = 1.62 \text{ M}\Omega$ ,  $R_{of} = 1.486 \text{ M}\Omega$

SP7.9.3 (1) 约为  $980 \text{ kHz}$ ; (2) 约为  $1 \text{ MHz}$

## 第8章

8.3.1 (1)  $P_{om} \approx 2.07 \text{ W}$ ; (2)  $R_b \approx 1570 \Omega$ ; (3)  $\eta \approx 24\%$

8.3.2 (1)  $P_{om} = 4.5 \text{ W}$ ; (2)  $P_{CM} \geq 0.9 \text{ W}$ ; (3)  $|V_{(BR)CEO}| \geq 24 \text{ V}$

8.3.3 (1)  $V_{CC} \geq 12 \text{ V}$ ; (2)  $I_{CM} \geq 1.5 \text{ A}$ ;  $|V_{(BR)CEO}| \geq 24 \text{ V}$ ; (3)  $P_V \approx 11.46 \text{ W}$ ;  
(4)  $P_{CM} \geq 1.8 \text{ W}$ ; (5)  $V_i \approx 8.49 \text{ V}$

8.3.4 (1)  $P_o = 12.25 \text{ W}$ ;  $P_{T1} = P_{T2} = 5.02 \text{ W}$ ,  $P_V = 22.29 \text{ W}$ ,  $\eta \approx 54.96\%$

(2)  $P_o = 25 \text{ W}$ ;  $P_T = 2P_{T1} \approx 6.85 \text{ W}$ ,  $P_V = 31.85 \text{ W}$ ,  $\eta \approx 78.5\%$

8.4.1  $V_{CC} \geq 24 \text{ V}$

8.4.2  $P_{om} = 2.25 \text{ W}$

8.4.3 (1)  $V_{C2} = 6 \text{ V}$ , 调整  $R_1$  或  $R_3$

(2) 增大  $R_2$

(3)  $P_{T1} = P_{T2} = 1156 \text{ mW} \gg P_{CM}$ , 会烧坏功放管

8.4.4 (1)  $P_o = 3.54 \text{ W}$ ; (2)  $P_V \approx 5 \text{ W}$

- 8.4.5  $P_o = 16 \text{ W}$ ;  $P_v \approx 21.6 \text{ W}$ ,  $P_T \approx 5.6 \text{ W}$ ,  $\eta \approx 74.1\%$
- 8.4.8 管子集电极输出功率  $P_{oc} = 53.4 \text{ mW}$ , 负载上得到的功率  $P_o = 42.7 \text{ mW}$ , 总效率  $\eta \approx 40\%$
- 8.4.9 (1) 管子集电极输出功率  $P_{oc} = 9 \text{ W}$ , 负载上得到的功率  $P_o = 7.2 \text{ W}$ ,  $P_v \approx 11.5 \text{ W}$ ,  $\eta \approx 62.6\%$
- (2) 通过管子的最大电流  $I_{cmax} = 1.5 \text{ A}$ , 管子承受的最大反向电压  $|V_{CEmax}| = 24 \text{ V}$ , 每只管子的最大管耗  $P_{T1} = P_{T2} = 1.25 \text{ W}$ , 未超过定额, 可用
- 8.5.1 (1)  $P_{om} \approx 5.1 \text{ W}$ ; (2)  $V_i \approx 64 \text{ mV}$
- 8.5.2 (1)  $P_{om} = 14.06 \text{ W}$ ; (2)  $P_v \approx 17.9 \text{ W}$ ,  $\eta \approx 78.5\%$
- 8.5.3 (1)  $A_{v1} = 2.5$ ,  $A_{v2} = -2.5$ ; (2)  $P_{om} \approx 0.28 \text{ W}$ ; (3)  $V_{im} \approx 5.2 \text{ V}$
- SP8.6.1  $P_{om} = 3.6952 \text{ W}$ ,  $P_{T1m} = 1.1036 \text{ W}$
- SP8.6.2  $32 \text{ V}$
- SP8.6.3 (1)  $P_o = 2.72 \text{ W}$ ; (2) 电源供给的功率  $P_v = 4.8 \text{ W}$

## 第9章

- 9.1.1 (1) 带通; (2) 低通; (3) 带阻; (4) 高通
- 9.1.2 (1) 带阻; (2) 低通; (3) 高通; (4) 带通
- 9.2.2 (2)  $|A_v(j\omega)| = 1$ ,  $\varphi = -\pi - 2\arctan(\omega RC)$
- 9.3.1  $\omega_H = \omega_C = 100 \text{ rad/s}$ ,  $A_{vF} = A_o = 1.586$
- 9.3.2  $\omega_o = 10^4 \text{ rad/s}$ ,  $f_o = 1592 \text{ Hz}$ ,  $BW = \omega_o/2\pi Q \approx 2347 \text{ Hz}$
- 9.3.3 (1)  $A_1(s) = -\frac{sCR_1}{1+sCR_1}$ ,  $A(s) = -\frac{1}{1+sCR_1}$
- (2)  $A_1$ ——一阶高通, 整个电路组成一阶低通
- 9.3.4  $\frac{V_o(s)}{V_i(s)} = -\frac{sCR_1}{1+sCR_1}$ , 一阶高通
- 9.3.5  $\frac{V_o(s)}{V_i(s)} = \frac{-sC_1R_f}{1+s(C_1R_1+C_fR_f)+s^2C_1C_fR_1R_f}$ , 带通
- 9.3.6 (1) 高通; (2)  $A_o = -1$ ,  $\omega_c = \frac{1}{C\sqrt{R_1R_2}}$ ,  $Q = \frac{1}{3}\sqrt{\frac{R_1}{R_2}}$
- 9.3.7  $A_{vF} = 3 - \frac{1}{Q} = 2$ , 峰值  $|A(j\omega)|_{max} = 2.828$ , 对应的角频率  $\omega = 2\sqrt{2}\pi \times 200 \text{ rad/s}$
- 9.3.9 (1) 二阶低通; (2) 三阶低通; (3) 三阶高通
- 9.6.2 (2)  $R_f \geq 2R_{e1}$ ,  $f_o \approx 58.5 \text{ Hz}$
- 9.6.4  $R_2$  断开时,  $v_o$  近似为方波, 峰-峰值为  $20 \text{ V}$
- 9.6.5  $R_p \approx 3.55 \text{ k}\Omega$
- 9.6.6 (2)  $R_p + R_2 > 2R_1 = 10.2 \text{ k}\Omega$ ; (3)  $f_o \approx 1591.5 \text{ Hz}$
- 9.6.8 (2)  $V_{om} \approx 8.35 \text{ V}$ ; (3)  $R_2 = 0$ , 电路停振; (4)  $R_2$  开路,  $v_o$  近似为方波, 峰-峰值约为  $28 \text{ V}$

9.7.3 (1) 图 9.7.3a 的  $f_0 \approx \frac{1}{2\pi \sqrt{LC_3}}$

(2) 图 9.7.3b 的  $f_0 \approx \frac{1}{2\pi \sqrt{L(C_3 + C_4)}}$

9.8.1 (1)  $v_o = 0$ ; (2)  $v_o = 6 \text{ V}$

9.8.4  $V_T = 1 \text{ V}$

9.8.5  $V_{T+} = 3 \text{ V}$ ,  $V_{T-} = -3 \text{ V}$ ,  $V_{OH} = 9 \text{ V}$ ,  $V_{OL} = -9 \text{ V}$

9.8.9  $f = \frac{R_2}{4R_1RC} = 3067.6 \text{ Hz}$

9.8.10 (1)  $v_{o1} = -0.15 \text{ V}$ ; (2)  $v_{o2} = 1.5 \text{ V}$ ,  $v_{o3} = 6 \text{ V}$

SP9.9.3 (1)和(2)分别为二阶和三阶低通滤波器; (3)为高通滤波器; (4)为全通滤波器; (5)为带通滤波器

SP9.9.4 振荡频率约为 1.053 kHz

SP9.9.5 振荡频率约为 353 kHz

SP9.9.6 (2)上、下限门限电压约为 3.2 V

SP9.9.7 振荡频率约为 3 kHz

## 第 10 章

10.1.1 (2)  $V_L = 0.9V_2$ ,  $I_L = 6.9 V_2/R_L$ ; (3)  $I_D = I_L/2$ ,  $V_{RM} = 2\sqrt{2}V_2$ ; (4)  $V_{2a} = V_{2b} = 33.3 \text{ V}$ ,  $I_D = 40 \text{ mA}$ ,  $V_{RM} = 94.2 \text{ V}$ , 选用 2CP6A ( $I_{DM} = 100 \text{ mA}$ ,  $V_{RM} = 100 \text{ V}$ )

10.1.2 (1)  $V_{L1} = 45 \text{ V}$ ,  $I_{L1} = 4.5 \text{ mA}$ ,  $V_{L2} = 9 \text{ V}$ ,  $I_{L2} = 90 \text{ mA}$ ; (2)  $I_{D1} = I_{L1} = 4.5 \text{ mA}$ ,  $V_{RM} = 141 \text{ V}$ ,  $I_{D2} = I_{D3} = 45 \text{ mA}$ ,  $V_{RM2} = V_{RM3} = 28.2 \text{ V}$

10.1.3 (1)  $I_D = 240 \text{ mA}$ ,  $V_{RM} = 28.2 \text{ V}$ , 选用 2CP1D ( $I_{DM} = 500 \text{ mA}$ ,  $V_{RM} = 100 \text{ V}$ )

(2)  $C = 1000 \mu\text{F}$ , 耐压  $V_{CM} > 28.2 \text{ V}$ , 选用  $1000 \mu\text{F}/50 \text{ V}$  电解电容

(3)  $V_2 = 20 \text{ V}$ ,  $I_2 = 720 \text{ mA}$

10.1.4  $V_{RM} = V_{CRM} = 2\sqrt{2} V_2$ ,  $V_{L1} = 4\sqrt{2} V_2$ ,  $V_{L2} = 3\sqrt{2} V_2$

10.1.5 (1)  $v_i$  瞬时极性为正时,  $D_3$ 、 $D_1$  导通, 电流从 A 流向 B

(2)  $I_M = (0.9V_i)/R$

(3)  $R = 9 \text{ k}\Omega$

(4)  $R = 10 \text{ k}\Omega$

10.2.1 (1)  $D_Z$  接反,  $D_Z$  正向导通,  $V_o = 0.7 \text{ V}$ ;  $R = 0$  时,  $D_Z$  损坏

(2)  $V_2 = 15 \text{ V}$ ,  $V_o = 6 \text{ V}$

(3)  $R_o = r_z = 20 \Omega$ ,  $\Delta V_o/\Delta V_i = 0.02$

10.2.2 (2)  $V_{REF} = 7 \text{ V}$ , 电压极性为正

10.2.3 (3)  $V_{Omin} = 15 \text{ V}$ ,  $V_{Omax} = 20 \text{ V}$ ; (4)  $V_{CE1max} = 18 \text{ V}$ ; (5)  $P_{Cl} = 5.4 \text{ W}$

10.2.6 (1)  $R_1 = (240 \sim 120) \Omega$

(2)  $V_o = 18.3 \text{ V}$ ;  $R_2 = 6.3 \text{ k}\Omega$ ;  $V_{imin} = 39 \text{ V}$

(4)  $V_o = (1.2 \sim 36.6) \text{ V}$