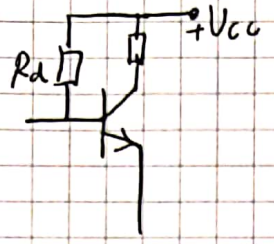
学号：19032051 姓名：高旭 班级：自动化5班

2.1 (a) $-V_{CC}$ 变为 $+V_{CC}$

(b) 

再添加一个电阻

(c) ~~干脆为 NPN 型，$-V_{CC}$ 变为 $+V_{CC}$~~

~~(d)~~ V_{BB} 反接，并在 V_{BB} 与地之间加一个电阻或电容

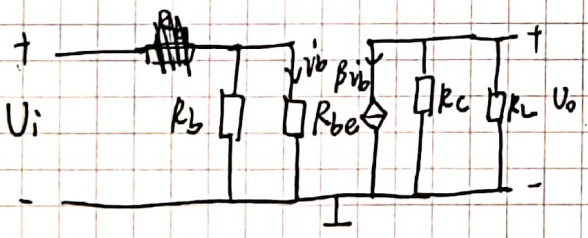
(d) 在 V_{BB} 与地间加一个电阻，C_1 左边为+，$-V_{CC}$ 与 C 极间加一个电阻

2.5 $V_{CC} = U_{BEQ} + I_{BQ} \cdot R_b = 0.7 + 20\times10^{-6}\times510\times10^{3}\ V$

$= 0.7 + 10.2 = 10.9\ V$

$U_o = V_{CC} - I_C R_C = V_{CC} - \beta I_{BQ} R_C = 10.9 - 80\times 20\times10^{-6}\times5\times10^{3}$

$= 2.9\ V$

动态时 

$R_{be} = 1\ k\Omega$

$U_o = -\beta i_b (R_C // R_L) = -80\times20\times10^{-6}\times2.5\times10^{3}$

$= -4\ V$

$\therefore \dot{A}_u = \frac{-4V}{20mV} = -200$ $R_i = R_b // R_{be} \approx 1\ k\Omega$

$R_o = R_C = 5\ k\Omega$ ~~$\frac{U_s R_i}{R_s + R_i}$~~ $\frac{U_s R_i}{R_s + R_i} = U_i$ $\therefore U_s = 60\ mV$.

(1) X (2) X (3) X (4) ✓

(5) ✓ (6) X (7) X (8) ✓

(9) ✓ (10) X (11) X (12) ✓

2.6 测静态电位时 U_I 置0

(1) $I_{BQ} \approx \frac{V_{CC}-U_{BE}}{R_{b2}} - \frac{U_{BE}}{R_{b1}}$ $U_O = V_{CC} - I_C R_C = V_{CC} - \beta I_{BQ} R_C$

$I_{BQ} = 0.0116\ mA$ $U_C \approx 7.9\ V$

(2) $U_{BE}=0$. T截止 $U_C = 15\ V$

(3) $I_{BQ} \approx \frac{V_{CC}-U_{BE}}{R_{b2}}$ $U_C = V_{CC} - I_C R_C$

$\approx 0.174\ mA$

临界饱合基极电流 $I_{BS} = \frac{V_{CC}-U_{CES}}{\beta R_C} \approx 0.024\ mA < 0.174\ mA$

∴ T饱合 $U_C = U_{CES} = 0.5\ V$

(4) R_{b2} 开路, T截止, $U_C = 15\ V$

(5) R_{b2} 短路, T损坏, 若 b-e 断开路则 $U_C = 15\ V$

若 b-e 短路, 则 U_C 未知.

(6) 若 R_C 短路, 则 $U_C = 15\ V$.

2.7 $R_L \to \infty$ 计算静态工作点 $I_{BQ} = \frac{V_{CC}-U_{BEQ}}{R_b} - \frac{U_{BEQ}}{R_s}$

$I_{CQ} = \beta I_{BQ} \approx 1.76\ mA$ $\approx 22\ \mu A$

$U_{CEQ} = V_{CC} - \beta I_{BQ} R_C \approx 6.2\ V$

b-e 间动态电阻 $r_{be} = r_{bb'} + \beta \frac{U_T}{I_{CQ}} = 100 + \frac{26\ mV}{22\ \mu A} \approx 1.3\ k\Omega$

$\dot{A}_u = -\frac{\beta i_b R_C}{i_b r_{be}} = -\frac{\beta R_C}{r_{be}} \approx -308$ $R_i = R_b // r_{be} \approx 1.3\ k\Omega$

$R_O = R_C = 5\ k\Omega$

$R_L = 5\ k\Omega$ Q点不变 $I_{BQ} \approx 22\ \mu A$ $I_{CQ} \approx 1.76\ mA$ $r_{be} \approx 1.3\ k\Omega$

$\dot{A}_u = -\frac{\beta (R_C // R_L)}{r_{be}} \approx -115$ $R_i = R_b // r_{be} \approx 1.3\ k\Omega$

$R_O = R_C = 5\ k\Omega$

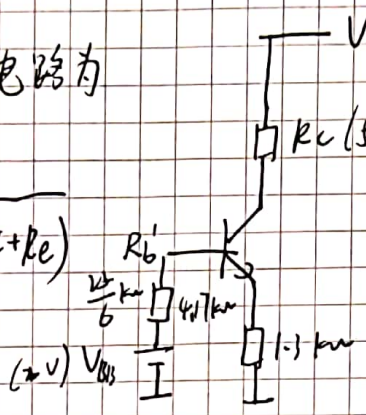
2.9 (1) $\frac{V_{CC}-U_{CEQ}}{\beta R_C} = I_{BQ}$ $R_b = \frac{\beta V_{CC}+U_{BEQ}}{I_{BQ}}$ 得 $R_b = 565\ k\Omega$

(2) $\dot{A}_u > 220$ $\dot{A}_u = -\frac{\beta(R_L'/\!/R_C)}{r_{be}} = -\frac{100\times(R_C/\!/5k\Omega)}{1k\Omega}$ ~~<220~~

$\therefore R_L' > 2200$ $\frac{R_L\times 5k}{R_L+5k} > 2200$ 即 $R_C > 3928.6\ \Omega$

$\therefore R_C$ 至少为 $3928.6\ \Omega$.

2.11 (1) 静态时 等效电路为



$V_{BB} = 2V$

$I_{BQ} = \frac{V_{BB}-U_{BEQ}}{R_b' + (1+\beta)(R_f+R_e)}$

得 $I_{BQ} \approx 10\ \mu A$

$I_{CQ} \approx 1\ mA$

$U_{CEQ} = V_{CC} - I_C(R_c/\!/R_L) - I_E\times(R_f+R_e) = 5.7\ V$

动态分析 $r_{be} = r_{bb'} + \beta\frac{U_T}{I_{CQ}} = 100 + 100\times\frac{26\ mV}{1\ mA} = 2700\ \Omega$

$\dot{A}_u = -\frac{\beta(R_C/\!/R_L)}{r_{be}+(1+\beta)R_f} \approx -7.6$

$R_i = R_{b1}/\!/R_{b2}/\!/(r_{be}+(1+\beta)R_f) \approx 3.7\ k\Omega$

$R_o = R_C = 5\ k\Omega$

(2) ~~因为 $U_{EQ} = U_{BQ} - U_{BEQ}$ 基本不变~~

因为 $I_{EQ} = \frac{(V_{BB}-U_{BEQ})(1+\beta)}{R_b' + (1+\beta)(R_f+R_e)} = \frac{V_{BB}-U_{BEQ}}{\frac{R_b'}{1+\beta} + R_f + R_e}$ 因为 $\frac{R_b'}{1+\beta} \ll R_f+R_e$ 小当 β 变为 200 时

I_{EQ} 基本不变 $\therefore U_{EQ}$ 基本不变 但 $I_{BQ} = \frac{V_{BB}-U_{BEQ}}{(1+\beta)(R_f+R_e)}$ 明显减小, 约为 $5\ \mu A$

(3) 若 C_e 开路 则 $R_i = R_{b1}/\!/R_{b2}/\!/(r_{be}+(1+\beta)(R_f+R_e)) \approx 8.1\ k\Omega$

$\dot{A}_u = -\frac{\beta(R_L/\!/R_C)}{r_{be}+R_f+R_e)(1+\beta)} \approx -1.92$

2.12 (1) 静态时 $U_{CC} = I_{BQ}R_b + (1+\beta)I_{BQ}R_e + U_{BEQ}$

得 $I_{BQ} = \dfrac{U_{CC}-U_{BEQ}}{R_b+(1+\beta)R_e} \approx 32.28\ \mu A$

$I_{CQ} = \beta I_{BQ} \approx 2.58\ mA$

$U_{CEQ} \approx U_{CC} - (1+\beta)I_{BQ}R_e \approx 7.14\ V$

(2) $R_L = \infty$

$\dot{A}_u = \dfrac{(1+\beta)R_e}{r_{be}+(1+\beta)R_e} \approx 0.996$

$R_i = R_b // [r_{be} + (1+\beta)R_e] \approx 110\ k\Omega$

~~$R_o = R_e = 3\ k\Omega$~~

$R_L = 3\ k\Omega$ $\dot{A}_u = \dfrac{(1+\beta)(R_e // R_L)}{r_{be}+(1+\beta)(R_e // R_L)} \approx 0.992$

$R_i = R_b // [r_{be} + (1+\beta)(R_e // R_L)] \approx 76\ k\Omega$

输出电阻与负载无关 $R_o = R_e // \dfrac{R_s // R_b + r_{be}}{1+\beta} \approx 37\Omega$

2.13 (1) 静态时 $I_{BQ} = \dfrac{U_{CC}-U_{BEQ}}{R_b+(1+\beta)R_e} \approx 31\ \mu A$

$I_{CQ} = \beta I_{BQ} \approx 1.86\ mA$

$U_{CEQ} \approx U_{CC} - I_{EQ}(R_c+R_e) = 4.56\ V$

动态时 $\dot{A}_u = -\dfrac{\beta(R_c // R_L)}{r_{be}} \approx -96$ $r_{be} = r_{bb'} + \beta\dfrac{U_t}{I_{CQ}}$

$\approx 939\ \Omega$

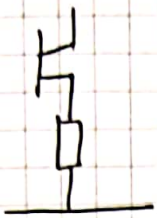
$R_i = R_b // r_{be} \approx 939\ \Omega$

$R_o = R_c = 3\ k\Omega$

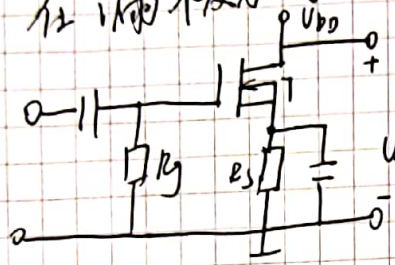
(2) 此时 $U_i = \dfrac{U_s R_i}{R_s+R_i} = 3.2\ mV$ $U_o = |\dot{A}_u| U_i = 307\ mV$

若 C_3 开路 $\dot{A}_u = -\dfrac{\beta(R_c // R_L)}{r_{be}+(1+\beta)R_e} \approx -1.45$ $U_i = \dfrac{R_i U_s}{R_s+R_i} \approx 9.6\ mV$ $U_o = |\dot{A}_u| U_i \approx 14\ mV$

2.14

(a)  在源极添加电阻

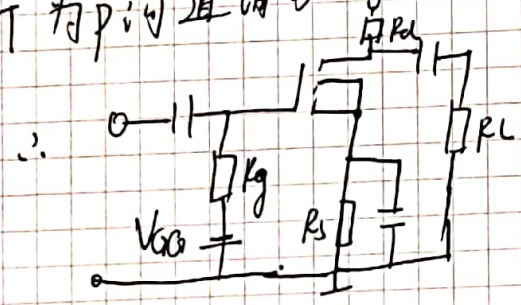
(b) 在漏极加电阻 R_d，在输入端加耦合电容



(c) T为p沟道增强型管 $\therefore U_{GS}<0$，$U_{DS}<0$

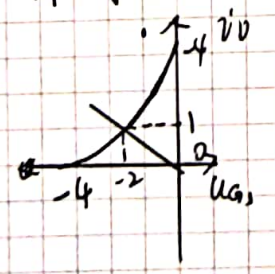
$+V_{DD}$ 变为 $-V_{DD}$

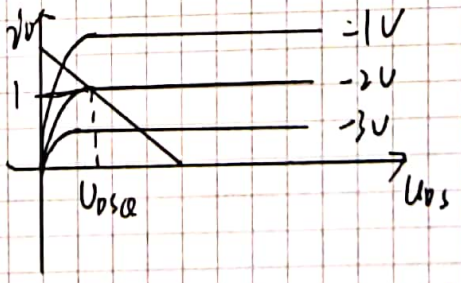
加个电源 V_{GG}



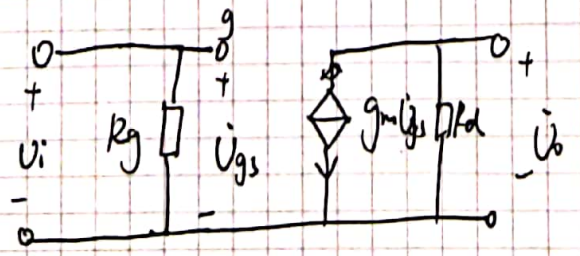
2.15 (1) 静态时该电路自给偏压 $U_{GS}=-i_D R_s$ $\therefore i_D=-\frac{1}{R_s}U_{GS}$

作图得 $I_{DQ}=1mA$ $U_{GSQ}=-2V$





$u_{DS}=V_{DD}-i_D(R_d+R_s)$ $\therefore U_{DSQ}\approx 3V$

(2) 

$\dot{A}_u=\frac{\dot{U}_o}{\dot{U}_i}=\frac{-g_m\dot{U}_{gs}R_d}{\dot{U}_{gs}}=-g_mR_d$

$g_m=\frac{-2}{U_{GS(off)}}\sqrt{I_{DO}I_{DQ}}=1ms$

$\therefore \dot{A}_u=-5$ $R_i=R_g=1M\Omega$

$R_o=R_d=5k\Omega$

2.11 (1) 若底部失真，则应降低 U_{GS}，则增大 R_1，R_3，降低 R_2 R_d 、

若顶部失真，则应升高 U_{GS}，则增大 R_2，R_d，减小 R_1，R_3

(2) 可减小 R_1，R_3，增大 R_2 来增大 U_{GS} 从而

增大 I_{DQ}，从而增大 g_m，或增大 R_d.