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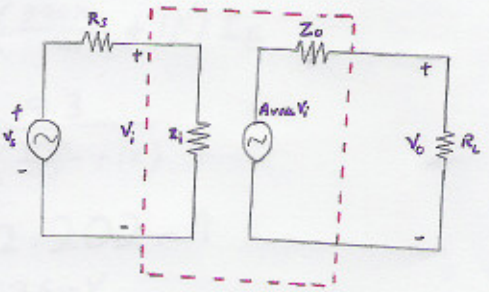
Year 2005/2006 S2
EG2002

Qn:1)

(a)



$Z_i = 1.2\,K\Omega$
$R_s = 100\Omega$
$A_{VNL} = -125$
$Z_o = 2.4K\Omega$
$R_L = 3.3K\Omega$

(b) $V_i = \left(\frac{Z_i}{Z_i + R_s}\right) V_s$

$\frac{V_i}{V_s} = \frac{Z_i}{Z_i + R_s}$ #

(c) $V_o = \left(\frac{R_L}{R_L + Z_o}\right) \times A_{VNL} V_i$

$\frac{V_o}{V_i} = -125\left(\frac{R_L}{R_L + Z_o}\right)$ #

(d) $V_s = \left(\frac{Z_i + R_s}{Z_i}\right) V_i$

$V_o = -125\left(\frac{R_L}{R_L + Z_o}\right) V_i$

$A_{VS} = \frac{V_o}{V_s}$

$= \frac{-125\left(\frac{R_L}{R_L + Z_o}\right) V_i}{\left(\frac{Z_i + R_s}{Z_i}\right) V_i}$

$= -125\left[\frac{R_L Z_i}{(Z_i + R_s)(R_L + Z_o)}\right]$ #

(e) $A_{VS} = -125\left[\frac{(3.3K\Omega)(1.2K\Omega)}{(1.2K\Omega + 100\Omega)(3.3K\Omega + 2.4K\Omega)}\right]$

$= -125\left[\frac{3.96\,M\Omega}{(1.3K\Omega)(5.7K\Omega)}\right]$

$= -125\,(.05344)$

$= -66.80$ #

(f)

$R_s = 0\Omega$ #

$R_L = \infty\Omega$ #

R_s is short circuit, R_L is open circuit.

(g)

$V_o = V_i A_{VNL}$

$V_s = V_i$

$\therefore A_{VL} = \frac{V_i A_{VNL}}{V_i}$

$= A_{VNL}$

$= -125$ #

Qn.2)

(a) $V_{cc} = I_B R_B + V_{BE} + I_E R_E$

$10 - 0.7 = \left(\frac{I_E}{1+120}\right)(390K) + I_E(1K\Omega)$

$9.3 = \left(\frac{390K}{121} + 1K\right) I_E$

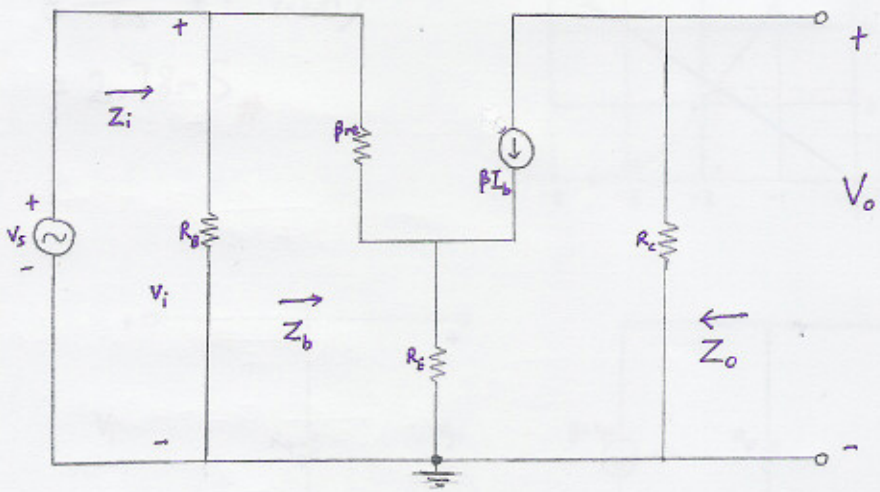
$I_E = \frac{9.3}{\left(\frac{390K}{121} + 1K\right)}$

$= 2.202\,mA$

$r_e = \frac{26mV}{2.202mA}$

$= 11.81\Omega$ #

(b)



$\beta = 120$

$R_B = 390K\Omega$

$R_E = 1K\Omega$

$R_c = 3.3K\Omega$

$\beta r_e = (120)(11.81)$

$= 1.4172K\Omega$

(c) $Z_i = R_B // Z_b$

$Z_b = \beta r_e + (1+\beta) R_E$

$= 1.4172K\Omega + (1+120)(1K\Omega)$

$= 122.417K\Omega$

$\therefore Z_i = (390K\Omega) // (122.417K\Omega)$

$= 93.171K\Omega$ #

$Z_o = R_c$

$= 3.3K\Omega$ #

(d) $V_o = -\beta I_b R_c$

$V_i = I_b \beta (r_e + R_E)$

$\therefore A_{v(NL)} = -\frac{\beta I_b R_c}{I_b \beta (r_e + R_E)}$

$= \frac{-3.3K\Omega}{(11.81\Omega + 1K\Omega)}$

$= -3.26$ #

(e) $R_{cc} = R_c + R_L$

$= 3.3K\Omega + \infty\Omega$

$= \infty\Omega$

$\therefore f_{LC} = \frac{1}{2\pi R_{cc} C_c}$

$= \frac{1}{2\pi(\infty)(0.47nF)}$

$= 0\,Hz$ #

Qn:3)

(a) Self-biasing & Common Source.

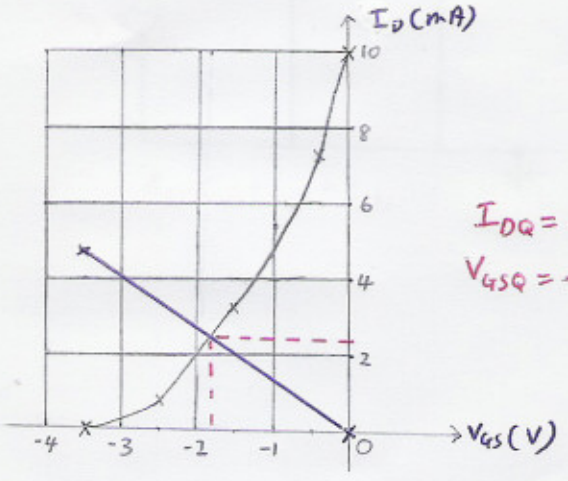
(b) $I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$

$I_D = (10mA)\left(1 - \frac{V_{GS}}{(-3.5)}\right)^2$

$I_D = -\frac{V_{GS}}{R_S}$

$I_D = -\frac{V_{GS}}{750\Omega}$

V_{GS}	0	-1.5	-2.5	-3.5	curve
I_D	10	3.27	0.81	0	curve
V_{GS}	0	-3.5			Line
I_D	0	4.67			Line



$I_{DQ} = 2.4mA$

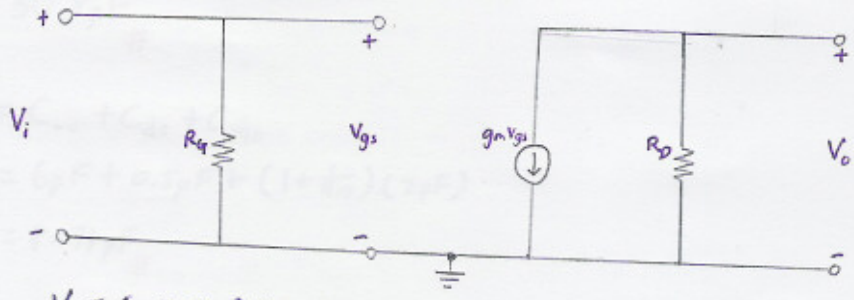
$V_{GSQ} = -1.8V$

$g_m = \frac{2I_{DSS}}{|V_P|}\left(1 - \frac{V_{GSQ}}{V_P}\right)$

$= \frac{2(10mA)}{3.5}\left(1 - \frac{(-1.8)}{(-3.5)}\right)$

$= 2.78mS$ #

(c)



$I_{DSS} = 10mA$

$V_P = -3.5V$

$R_G = 10M\Omega$

$R_D = 1.5K\Omega$

$V_o = (-g_m V_{gs})(R_D)$

$V_i = V_{gs}$

$A_V = \frac{V_o}{V_i}$

$= -g_m R_D$

$= -2.78mS\,(1.5K\Omega)$

$= -4.17$ #

(d)

$V_o = -g_m V_{gs} R_D$

$V_i = V_{gs} + g_m V_{gs} R_S$

$= V_{gs}(1 + g_m R_S)$

$A_V = \frac{V_o}{V_i}$

$= \frac{-g_m R_D}{1 + g_m R_S}$

$= -1.35$ #

4)

(a) Fixed Biasing

(b) $V_o = -g_m V_{gs} R_D$

$V_i = V_{gs}$

$A_V = \frac{V_o}{V_i}$

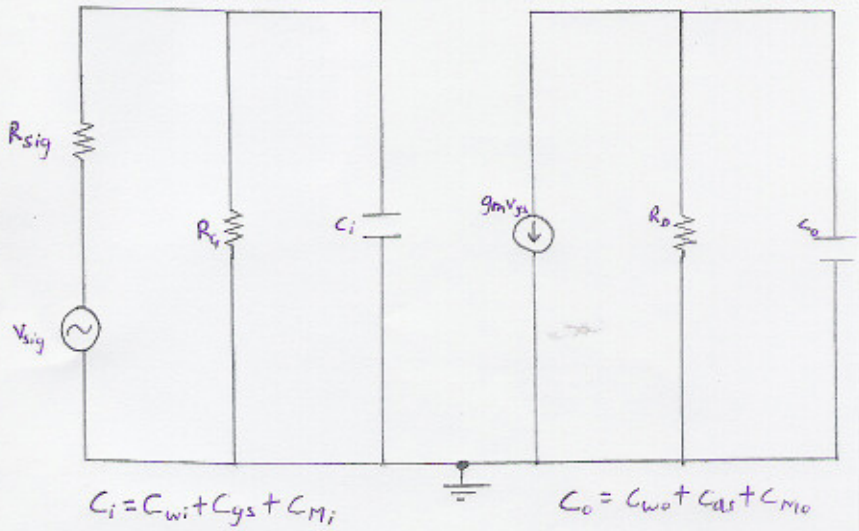
$= -g_m R_D$

$= -(2mS)(4.7K\Omega)$

$= -9.4$

$A_v(dB) = 20\lg 9.4$

$= 19.46dB$ #



$C_i = C_{wi} + C_{gs} + C_{Mi}$ $\quad$ $C_o = C_{wo} + C_{ds} + C_{Mo}$

(c) (i)

$C_i = C_{wi} + C_{gs} + C_{Mi}$

$= 5pF + 5pF + (1 - A_v) C_{gd}$

$= 10pF + (1 + 9.4)(2pF)$

$= 30.8pF$ #

(ii) $C_o = C_{wo} + C_{ds} + C_{Mo}$

$= 6pF + 0.5pF + (1 + \frac{1}{9.4})(2pF)$

$= 8.71pF$ #

(d) $F_{Hi} = \frac{1}{2\pi (R_{sig} // R_i)(C_i)}$

$= \frac{1}{2\pi (10K\Omega // 1M\Omega)(30.8pF)}$

$= 521.96 KH_z$

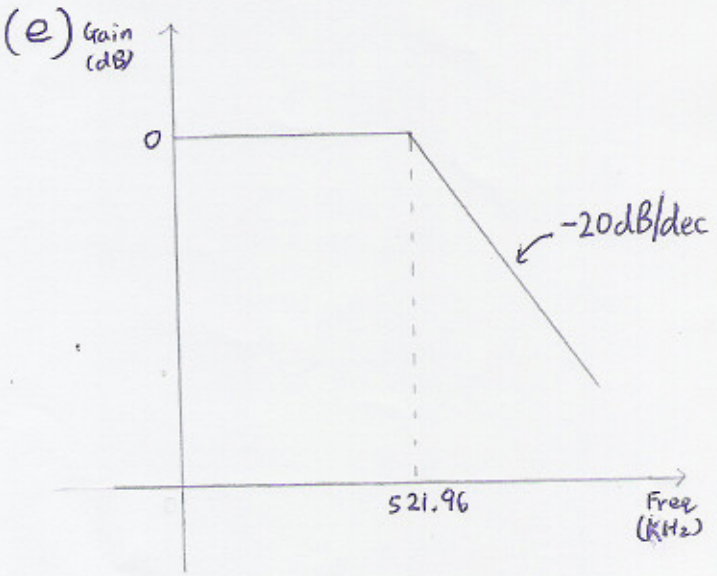
$F_{Ho} = \frac{1}{2\pi (R_D)(C_o)}$

$= \frac{1}{2\pi (4.7K\Omega)(8.71pF)}$

$= 3.887 MH_z$

$\therefore f_H = 521.96 KH_z$ #

(e)



Qn:5)

(a) (i) Both Q_1 and Q_2 are self-basing and Common Source Amplifier #

(ii) $V_{in1} = V_{gs1}$

$V_{out1} = -g_m V_{gs1} (R_{D1} // R_{G2})$

$A_{v_1} = \frac{V_{out1}}{V_{in1}}$

$= -g_m (R_{D1} // R_{G2})$

$= -2.51\,mS\,(2.2K // 10M)$

$= -5.52$ #

$V_{in2} = V_{gs2}$

$V_{out2} = -g_m V_{gs2} (R_{D2} // R_L)$

$A_{v_2} = \frac{V_{out2}}{V_{in2}}$

$= -g_m (R_{D2} // R_L)$

$= -2.51mS\,(2.2k // 2.2k)$

$= -2.76$ #

(iii) $\frac{V_o}{V_s} = A_{v1} \times A_{v2}$

$= -5.52 \times -2.76$

$= 15.24$ # ($V_s = V_i$, cause no R_s)

(b) $I_B = \frac{V_{cc} - V_{BE}}{R_B + \beta_D R_E}$

$= \frac{16 - 1.4\,V}{2.4M\Omega + 8000\,(510)}$

$= \frac{14.6\,V}{6.48M\Omega}$

$= 2.25\,\mu A$

$I_E = (1 + \beta_D) I_B$

$= (1 + 8000)(2.25\,\mu A)$

$= 18.03\,mA$ #

Qn: 6)

(a)(i) $A_{CL} = -\frac{R_f}{R_i}$

$= -\frac{200k\Omega}{1k\Omega}$

$= -200$ #

(ii) $Z_i = R_i$

$= 1k\Omega$ #

(iii) $Z_o = Z_{o(op\text{-}amp)}$

$= 60\Omega$ #

(iv) $CMRR = \left|\frac{A_{CL}}{A_{CM}}\right|$

$= \left|\frac{-200}{0.002}\right|$

$= |-100k|$

$= 100 \times 10^3$ #

(v) $f_{max} = \frac{\text{slew Rate}}{2\pi V_p}$

$= \frac{2V/\mu S}{2\pi(14)}$

$= 22.74 KHz$ #

(b) (i)

$V_o = -\left(\frac{R_f}{R_2}V_i + \frac{R_f}{R_1}V_i\right)$

$= -R_f V_i \left(\frac{1}{R_1} + \frac{1}{R_2}\right)$ # shown

(ii) $V_o = -(5.6k\Omega)(150mV)\left(\frac{1}{2.2k\Omega} + \frac{1}{3.9k\Omega}\right)$

$= -0.597V$ #