1.

由公式 ∵ 單位輸入功率 $= \frac{E^2}{\eta_0} = \frac{E^2}{120\pi}$

∴ $P_r = \frac{E}{\eta_0} \times \frac{g\lambda^2}{4\pi}$

$= \frac{g\lambda^2 E^2}{480\pi^2} = \frac{gC^2E^2}{480\pi^2 F^2}$

∵ $g = 1 = 0\,dBi$

∴ $P_r\,(mw) = \frac{C^2E^2}{480\pi^2F^2} \times 1000\,(mW)$

$= \frac{(3\times10^8)^2\ E^2(\mu V/m)\times10^{-12}}{480\pi^2\ F^2_{MHz}\times10^{12}} \cdot \times10^3$

$= \frac{1.9\times10^{-8}\ E^2(\mu V/m)}{F^2(MHz)}$

取dB → $E(dB\,\mu V/m) = P_r(dBm) + 20\log F(MHz) + 77.2$

測試天線的設備，必須考慮天線場強度，

頻率越大，則天線場強度越大

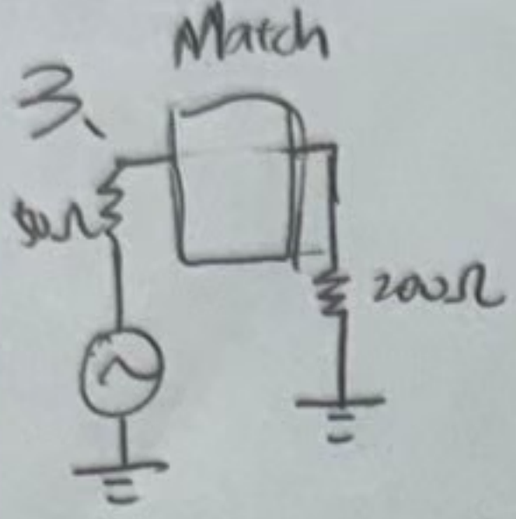
2. 由公式知

$I_{ac} = 0.8\times(I_{dc} - I_{ch}) = 24mA$

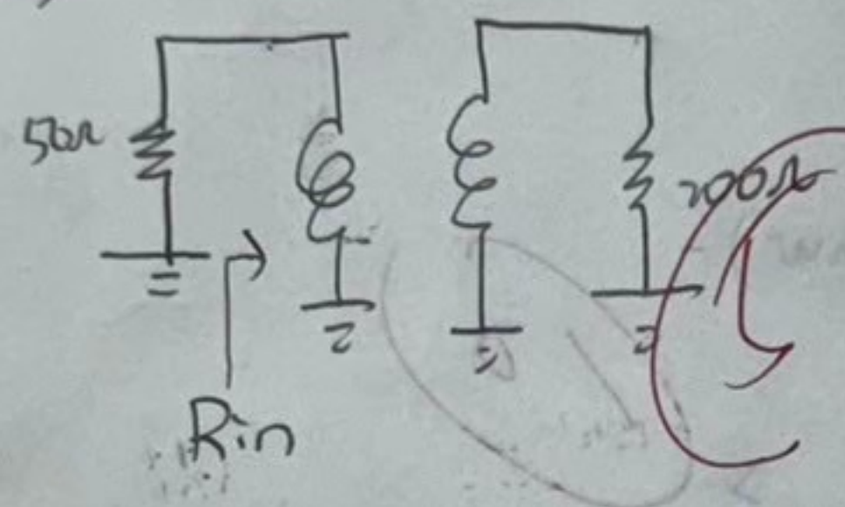
∴ $V_{s,p} = 1.32V$, $V_{rms} = \frac{1.32}{\sqrt{2}}$

$dBm = 10\log\left[\frac{(1.32/2)^2}{2\times50}/0.001\right] = 6.39\,(dBm)$

3. Match



(a) 1 : n



$R_{in} = \frac{200}{n^2} = 50 \quad \therefore n = 2$

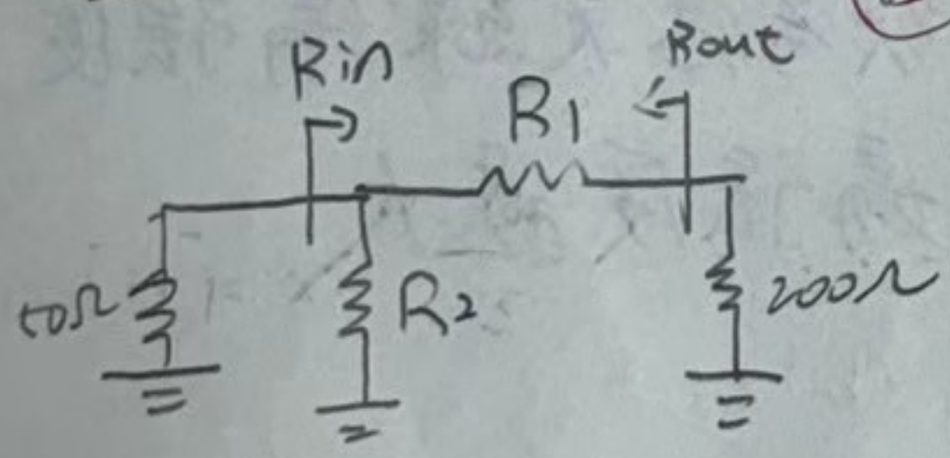
(b)

$S_{11} = S_{22} = 0$

互易 $\Rightarrow S_{21} = S_{12} = \frac{V_{3/2}}{V_{3/2}} \cdot \frac{V_{200}}{1/350} = 1$

(c) Insertion loss $= 20 \log |S_{21}| = 0\,dB$

(d)



$R_{in} = 50 = R_2 // (R_1 + 200)$

$R_{out} = R_1 + (R_2 // 50)$

$\Rightarrow R_1 = 3R_2$

(e)

$S_{11} = \frac{R_{in} - 50}{R_{in} + 50} = 0$ #

$(R_{in} = 57.735 // (200 + 173.2) = 50)$

$S_{22} = \frac{R_{out} - 200}{R_{out} + 200} = 0$ #

$R_{out} \doteq 200$

$S_{21} = \frac{b_2/\sqrt{R_L}}{a_1/\sqrt{R_s}}$

$= \frac{V_2/2}{V_b/2} \cdot \frac{200}{173.2 + 200} \cdot \frac{50}{50}$

$= 0.268$ #

(f) Insertion loss $= 20 \log |S_{21}|$

$= -11.44\,dB$ #

$R_1 = 100 \cdot \frac{3}{5} = 173.2$

$R_2 = \frac{100}{5/3} = 57.735$

4.

$$W_{IM} - W_{LO} = W_{LO} - W_{RF}$$

$$RF = A_{RF}\cos W_{RF}t + A_{IM}\cos W_{IM}t$$

$$X_A(t) = (A_{RF}\cos W_{RF}t + A_{IM}\cos W_{IM}t)\, A_{LO}\sin W_{LO}t$$

BPF ↘

$$= \frac{A_{RF}A_{LO}}{2}\sin(W_{LO}-W_{RF})t + \frac{A_{IM}A_{LO}}{2}\sin(W_{LO}-W_{IM})t$$

$$= \frac{A_{RF}A_{LO}}{2}\sin(W_{LO}-W_{RF})t - \frac{A_{IM}A_{LO}}{2}\sin(W_{IM}-W_{LO})t$$

經90相移電路 →

$$-\frac{A_{RF}A_{LO}}{2}\cos(W_{LO}-W_{RF})t + \frac{A_{IM}A_{LO}}{2}\cos(W_{IM}-W_{LO})t$$

$$= X_C(t)$$

$$X_B(t) = (A_{RF}\cos W_{RF}t + A_{IM}\cos W_{IM}t)\, A_{LO}\cos W_{LO}t$$

$$= \frac{A_{RF}A_{LO}}{2}\cos(W_{RF}+W_{LO})t + \frac{A_{RF}A_{LO}}{2}\cos(W_{RF}-W_{LO})t$$

$$+ \frac{A_{IM}A_{LO}}{2}\cos(W_{IM}+W_{LO})t + \frac{A_{IM}A_{LO}}{2}\cos(W_{IM}-W_{LO})t$$

BPF ⟹ $\frac{A_{RF}A_{LO}}{2}\cos(W_{RF}-W_{LO})t + \frac{A_{IM}A_{LO}}{2}\cos(W_{IM}-W$

(b)

$$\text{Signal} = X_B(t) + X_C(t)$$

$$= A_{IM}A_{LO}\cdot\cos(W_{IM}-W_{LO})t$$

無法得到想要的 RF 訊號

(b) 可將 90° 相移電路由 A 改向 B

5、

(a) 先將dB轉為實際值再代公式

$$NF = F_1 + \frac{F_2-1}{G_1} + \frac{F_3-1}{G_1G_2} + \cdots$$

$$= 2 + \frac{20-1}{10} + \frac{2-1}{10\times31.62} + \frac{10-1}{10\times31.62\times0.5} + \frac{2-1}{10\times31.62\times0.5\times100}$$

$$= 3.96 = 5.976\,dB$$ (5)

(b) Total gain

$$10+15-3+20-3 = 39\,(dB)$$ (5)

(c) $-93+39 = -54\ dBm$ (5)

(d) $$\frac{1}{OIP3} = \frac{1}{OIP3_1 G_2\cdots G_n} + \frac{1}{OIP3_2 G_3\cdots G_n} + \cdots$$

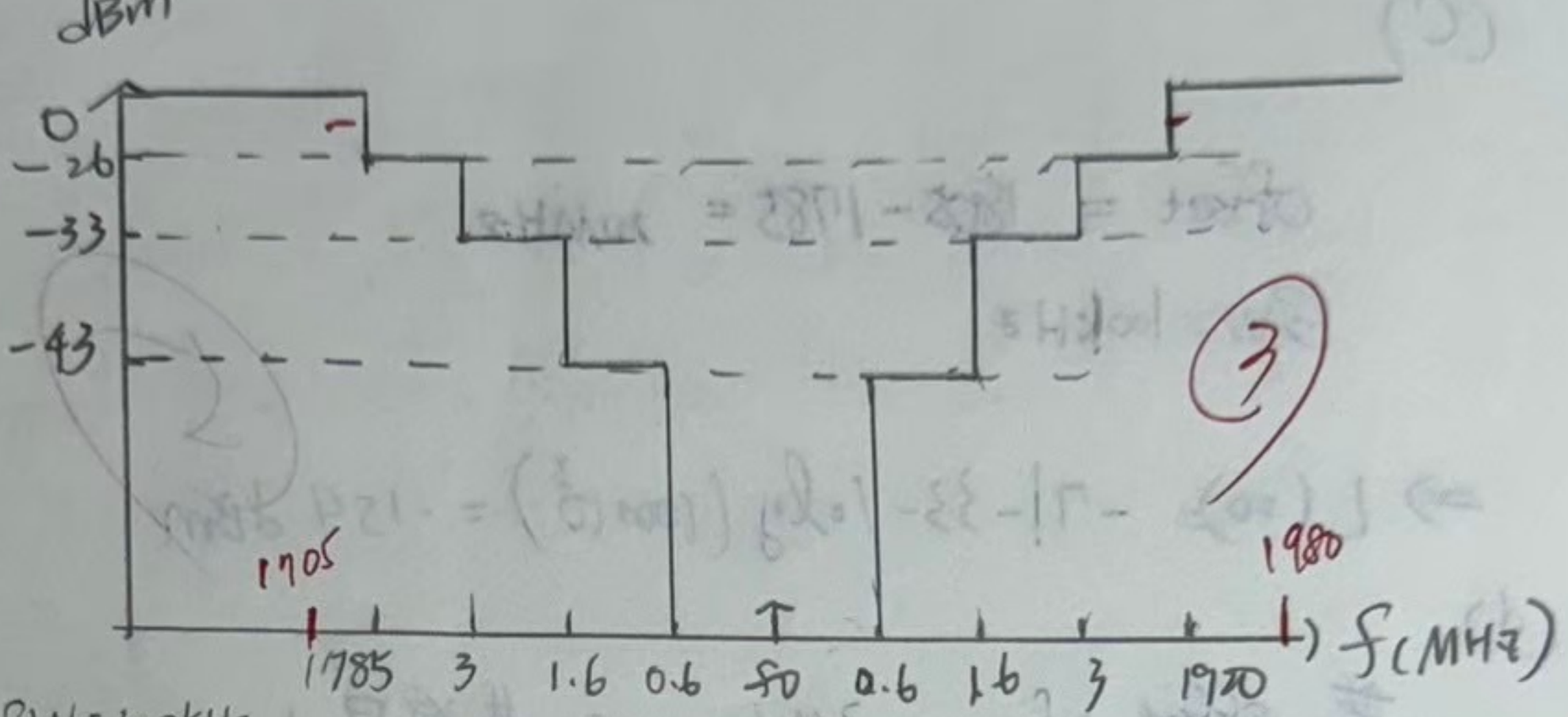
$$\fallingdotseq \frac{1}{7920} + \frac{2}{281} + 0 + \frac{1}{50} + 0 = 0.0272$$

$$= -15.654\,dBm$$ (5)

$$\therefore O_{IP3} = 15.654\ dBm$$

6.

(a)



(b) BW = 200kHz

1. offset $\Delta f = 0.6$ MHz

$\Rightarrow L(0.6) = -99 - 9 + 43 - 10\log(200\times10^3) = -18$ dBm

2. $\Delta f = 1.6$ MHz

$\Rightarrow L(1.6) = -99 - 9 + 33 - 10\log(200\times10^3) = -128$ dBm

3. $\Delta f = 3$ MHz

$L(3) = -99 - 9 + 26 - 10\log(200\times10^3) = -135$ dBm

4. $\Delta f = 20$ MHz

$L(20) = -99 - 9 + 12 - 10\log(200\times10^3) = -149$ dBm

(c)

offset = 1805 − 1785 = 20MHz

BW = 100kHz

$\Rightarrow L(20) = -71 - 33 - 10\log(100\times10^3) = -154\ dBm$

(d)

若 offset freq = 3MHz 基準是 1.6MHz

則 phase noise 上升 5.46dB (∵斜率為 20dB/dec)

$-138 + 5.46 = -132.54$

若是 0.6MHz 頻偏的 phase noise 為

$-138 + 14\ dB = -124$ ⇒ 可滿足

若 offset freq = 1.6 MHz

基準 = 3MHz 則 phase noise = $-128 - 5.46 = -133.46$

基準 = 0.6MHz 則 phase noise = $-128 + 8.52 = -119.5$

⇒ 無法滿足 3MHz

若 offset freq = 0.6MHz

基準 = 3MHz, 則 phase noise = $-118 - 14 = -132$

基準 = 1.6MHz, 則 phase noise = $-118 - 8.52 = -126.5$

⇒ 皆無法滿足

∴ 整體來說, 3MHz 頻偏的要求最嚴格