

ASSIGNMENT 7

TADIPATRI UDAY KIRAN REDDY
EE19BTECH11038

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Problem 1

(a)

$$I_D = 1A$$
$$V_o = 1.3 + V_s$$

(b)

$$NoisePSD = 1.69 * 2 * 1.6 * 10^{-19} * 1$$
$$\Rightarrow NoisePSD = 5.41e - 19W/Hz$$

(c)

Here the gain is 1, any addition of resistance in series will reduce the gain. Thus there is **no resistance which can give the same gain.**

Problem 2

For the total chain,

$$F_{eff} = 1 + \frac{V_{n,in_3}^2}{(A_{p1}A_{p2}A_{p3})^2 V_{n,s}^2} + \frac{V_{n,in_2}^2}{(A_{p1}A_{p2})^2 V_{n,s}^2} + \frac{V_{n,in_1}^2}{(A_{p1})^2 V_{n,s}^2}$$

Take intermediate stage say ith stage,

$$F_i = \frac{A_{pi}^2 V_{n,in_i}^2 + V_{n,in_{i+1}}^2}{A_{pi}^2 V_{n,in_i}^2} = 1 + \frac{V_{n,in_{i+1}}^2}{A_{pi}^2 V_{n,in_i}^2}$$

And since, $A_{pi} = \frac{V_{in_{i+1}}}{V_{in_i}}$.

$$F_{eff} = 1 + (1 - F_1)(1 - F_2)(1 - F_3) + (1 - F_1)(1 - F_2) + (1 - F_1)$$

Problem 3

We find gain from input to output and just multiply the input noise PSD with square of magnitude of gain.

(a)

$$\frac{V_o}{V_{in}} = \frac{1}{sCR + 1}$$
$$NoisePSD = AvAv^*V_n^2 \Rightarrow \boxed{NoisePSD = \frac{1}{1 + (\omega CR)^2}}$$

(b)

$$\frac{V_o}{V_{in}} = \frac{1}{s^2LC + sCR + 1}$$
$$\Rightarrow \boxed{NoisePSD = \frac{V_n^2}{(1 - \omega^2LC)^2 + (\omega CR)^2}}$$

(c)

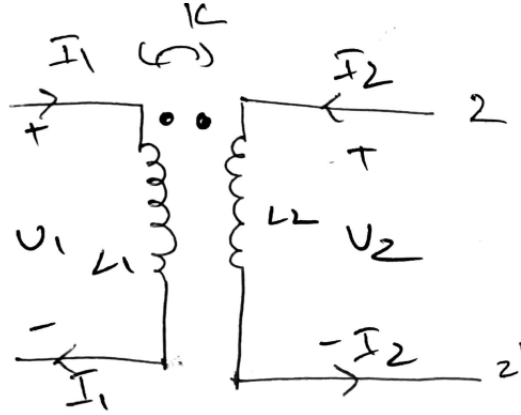
$$\frac{V_{o1}}{V_{in}} = \frac{s^2LC_2 + 1}{s^3RLC_1C_2 + s^2LC_2 + sR(C_1 + C_2) + 1}$$
$$\Rightarrow \boxed{NoisePSD_1 = V_n^2 \frac{(1 - \omega^2LC_2)^2}{(1 - \omega^2LC_2)^2 + (\omega^3RLC_1C_2 - \omega R(C_1 + C_2))^2}}$$
$$\frac{V_{o2}}{V_{in}} = \frac{1}{s^3RLC_1C_2 + s^2LC_2 + sR(C_1 + C_2) + 1}$$
$$\Rightarrow \boxed{NoisePSD_2 = V_n^2 \frac{1}{(1 - \omega^2LC_2)^2 + (\omega^3RLC_1C_2 - \omega R(C_1 + C_2))^2}}$$

Problem 4

Problem 5

We can find Z-parameters for both the models and just equate corresponding parameters.

Model 1



$$V_1 = sL_1 I_1 + sM I_2$$

$$V_2 = sM I_1 + sL_2 I_2$$

$$M = K \sqrt{L_1 L_2}$$

Model 2

$$V_1 = s(L_s + L_p)I_1 + sNL_p I_2$$

$$V_2 = sNL_p I_1 + sN^2 L_p I_2$$

From above equations we conclude that,

$$L_1 = L_s + L_p$$

$$NL_p = K \sqrt{L_1 L_2}$$

$$N^2 L_p = L_2$$

$$\Rightarrow N = \frac{1}{K} \sqrt{\frac{L_2}{L_1}}$$

$$\Rightarrow L_p = K^2 L_1 \Rightarrow L_s = (1 - K^2) L_1$$

Problem 6

At receiver,

$$NF = SNR_{in} - SNR_{out} = 10dB$$

$$SNR_{in} = 10dB + SNR_{out} \geq 10dB$$

$$\Rightarrow P_{Rx} \geq P_{noise} + 10dB \Rightarrow P_{Tx} - P_{atten} \geq P_{noise} + 10dB$$

$$\Rightarrow P_{atten} \leq P_{Tx} - (P_{noise} + 10dB)$$

Assuming the circuits are matched, P_{noise} would be $-173.8 + 10\log_{10}B$ which is -123.8dB. Therefore,

$$P_{atten} \leq 143.8dB$$

Maximum of 143.8dB of atmospheric attenuation is allowed.