Quiz 1

1. Consider an input signal

$$x(t) = (5\cos\omega_1 t + 5\cos\omega_2 t) \text{ volts}$$

given to a system whose i/p ($x(t)$) & o/p ($y(t)$) are related as follows

$$y(t) = \alpha_0 + \alpha_1 x(t) + \alpha_2 x^2(t) + \alpha_3 x^3(t)$$

Given,

$\alpha_0 = 0,\ \alpha_1 = 20,\ \alpha_2 = 1.33,\ \alpha_3 = -1.66$

$\omega_1 = 2\pi \times 2 \times 10^9$ rad/s, $\omega_2 = 2\pi \times 2.01 \times 10^9$ rad/s.

a. What will the value of $A_{in,IP3}$ be (in dBV)? (2 marks)

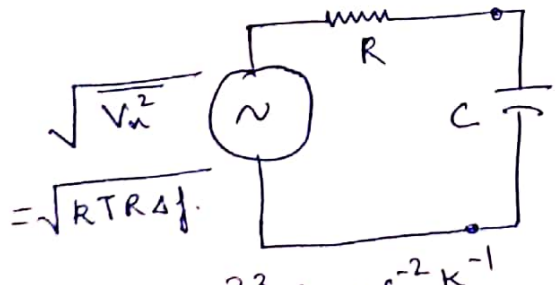
b. " " " " " $A_{out,IP3}$ " (in dBV)? (1 mark)

c. What will be frequencies corresponding to the intermodulation products be? (in rad/s) (1 mark)

Now, say $x(t) = (5\cos\omega t)$ volts $\left[\omega = 2\pi \times 2 \times 10^9 \text{ rad/s}\right]$

d. What will the value of P_{1dB} be? (1 mark)

2. Consider the circuit shown below.



$k = 1.38 \times 10^{-23}\ m^2 kg\ s^{-2} K^{-1}$

a. Find the expression for the PSD of the mean square noise voltage, $\overline{V_n'^2}$ stored in the capacitor C. (2 marks)

b. If $T = 298$ K, $C = 2$ pF, what is the value of $\overline{V_n'^2}$ (1 mark)

3. Consider the 2, 2-port N/W's shown below. (2 marks)

In what order should the 2 N/W's be connected so as to obtain minimum overall N.F.

Formula Sheet

Formulas given

Given a system,

$$y(t) = \alpha_0 + \alpha_1 x(t) + \alpha_2 x(t)^2 + \alpha_3 x^3(t)$$

1. for $x(t) = A_1 \cos \omega_1 t + A_2 \cos \omega_2 t$

$A_1 \approx A_2$

$$y(t) = (\alpha_1 A_1 + \dots) \cos \omega_1 t + (\alpha_1 A_2 + \dots) \cos \omega_2 t$$

$$+ \frac{3}{4} \alpha_3 A_1^2 A_2 \cos(2\omega_1 - \omega_2) + \frac{3}{4} \alpha_3 A_1 A_2^2 \cos(2\omega_2 - \omega_1)$$

2. for $x(t) = A_{in} \cos \omega_2 t$

$$y(t) = \alpha_0 + \frac{\alpha_2 A_{in}^2}{2} + \left(\alpha_1 A_{in} + \frac{3\alpha_3 A_{in}^2}{4}\right) \cos \omega t$$

$$+ \alpha_2 \frac{A_{in}^2}{2} \cos(2\omega t) + \frac{\alpha_3 A_{in}^3}{4} \cos 3\omega t$$

$\overline{V_n^2} = 4RTR\Delta f$

3. R noisy $\equiv$ noiseless

4. $dBV = 20 \log_{10}(A)$ ↓ in volts