Quiz 3

Communication Systems (EE 308), Autumn'19

Nov. 7, 2019; Total: 10 marks; Time: 55 minutes

Note:

- *You are allowed to use ONE A4 sheet with handwritten notes on ONE side.*
- *You are allowed to use any result discussed in class without proof. For all other results, a proof needs to be provided.*

QUESTION 1 (1 + 1 + 1 = 3 MARKS)

The power spectral density of a narrowband noise $n(t)$ is as shown in Fig. 1. The carrier frequency is 5 Hz.

(a) Find the power spectral densities of the in-phase and quadrature components, $n_I(t)$ and $n_Q(t)$, of $n(t)$.

(b) Find the cross-spectral density of $n_I(t)$ and $n_Q(t)$.

(c) Find the average powers of $n_I(t)$ and $n_Q(t)$.

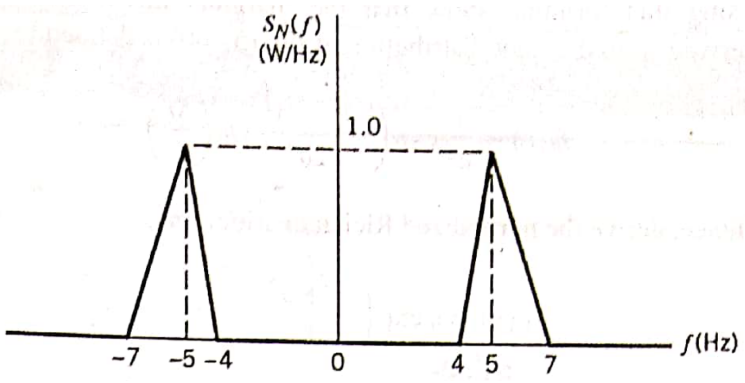

Fig. 1. The figure for Question 1.

QUESTION 2 (3 MARKS)

A DSB-SC modulated signal is transmitted over a noisy channel, with the power spectral density of the noise being as shown in Fig. 2. The message bandwidth is 4 kHz and the carrier frequency is 200 kHz. Assuming that the average power of the modulated wave is 10 watts, determine the output signal-to-noise ratio of the receiver.

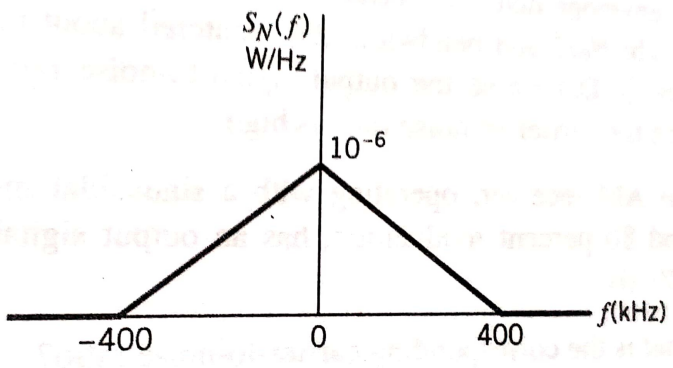

Fig. 2. The figure for Question 2.

QUESTION 3 (2 MARKS)

The message signal $m(t)$ has peak value $m_p = 1$ V, i.e., $-1 \leq m(t) \leq 1$ for all t. Also, $m(t)$ has a bandwidth of 5000 Hz and power of 0.1 W, and the channel has a bandwidth of 100 kHz and attenuation of 80 dB. The noise is white with power spectral density $\frac{N_0}{2} = 0.5 \times 10^{-12}$ W/ Hz and the transmitter power is 10 kW. If FM is employed, what is the highest possible output SNR?

QUESTION 4 (2 MARKS)

An unmodulated carrier, $A_c \cos(2\pi f_c t)$, of amplitude A_c and frequency f_c, and band-limited white noise are summed and then passed through an ideal envelope detector. Assume the noise power spectral density to be of height $\frac{N_0}{2}$ and bandwidth $2W$, centred about the carrier frequency f_c. Determine the output signal-to-noise ratio for the case when the carrier-to-noise ratio is high.