# MATHEMATICAL QUESTIONS

## Question 1

**Calculate the power content of the SSB signal $u(t) = A_c m(t)\cos(2\pi f_c t) \mp A_c \hat{m}(t)\sin(2\pi f_c t)$.**

## Question 2

**Show that if the SSB signal**

$$u(t) = A_c m(t)\cos(2\pi f_c t) \mp A_c \hat{m}(t)\sin(2\pi f_c t)$$

**passes an AWGN channel, as shown in Fig. 1, the SNR at the output of the demodulator is**

$$(\frac{S}{N})_o = \frac{A_c^2 P_M}{N_0 W} = \frac{P_R}{N_0 W}$$

**, where $N_0/2$ and $W$ are noise power spectral density and message bandwidth, respectively, while $P_M$ and $P_R$ denote message and received power, respectively.**

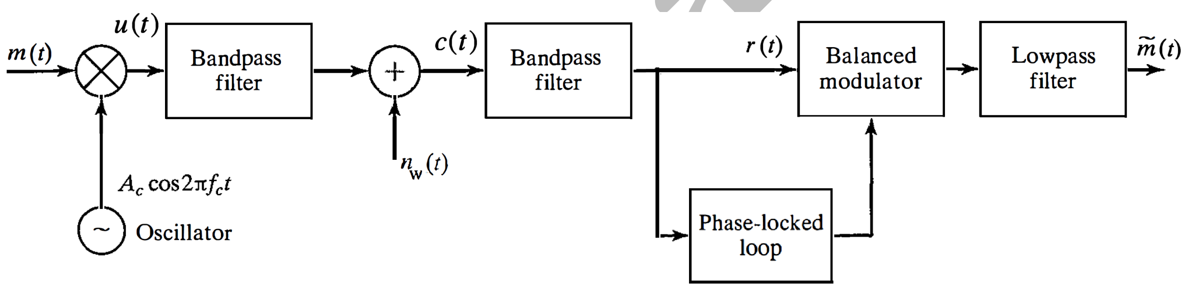


Figure 1: SNR analysis of SSB modulation in an AWGN channel.

## Question 3

**The DSB signal $u(t) = A_c m(t)\cos(2\pi f_c t)$ passes the bock diagram of Fig. 2, where $N_0/2$ and $W$ are noise power spectral density and message bandwidth, respectively. The frequency response of the bandpass filter at the input of the demodulatior is**

$$H(f) = \begin{cases} \sqrt{B^2 - (f - f_c)^2}, & |f - f_c| < W \\ \sqrt{B^2 - (f + f_c)^2}, & |f + f_c| < W \ , \quad B > W \\ 0, & \textbf{otherwise} \end{cases}$$

Question 3 continued on next page...

**while the bandpass filter at the output of the modulator is described by**

$$\begin{cases} \frac{1}{H(f)}, & H(f) \neq 0 \\ 0, & H(f) = 0 \end{cases}$$

**. Calculate the SNR at the output of the demodulator.**

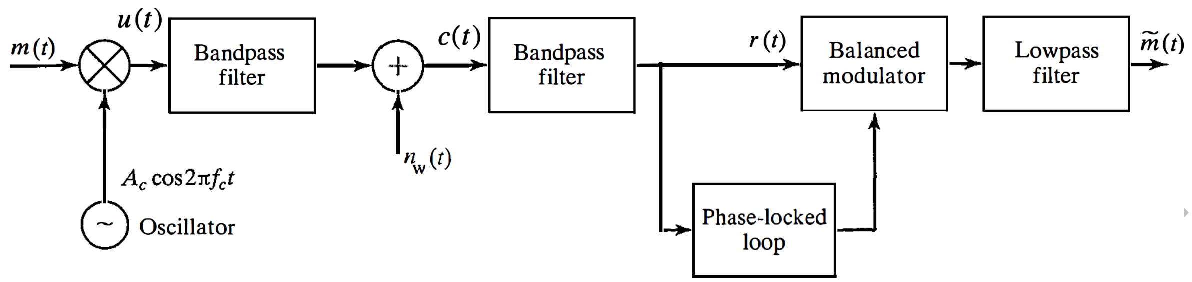


Figure 2: SNR analysis of DSB modulation in a linear filtered AWGN channel.

## Question 4

**Find expressions for the in-phase and quadrature components, $x_c(t)$ and $x_s(t)$, as well as the envelope and phase, $V(t)$ and $\Theta(t)$ for DSB and SSB signals.**

## Question 5

**The message signal $m(t)$ is applied to the system shown in Fig. 3 to generate the signal $y(t)$.**

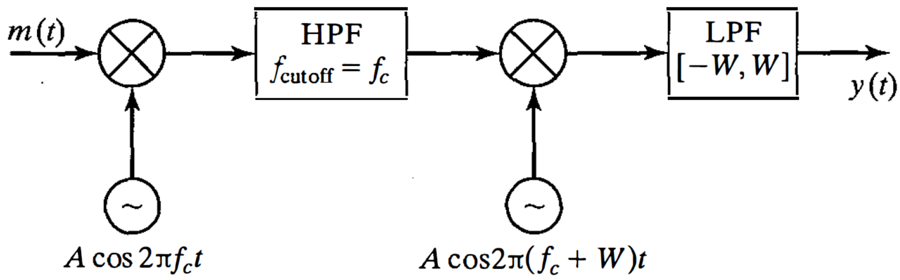


Figure 3: A sample scrambler.

(a) *Find the spectrum of $y(t)$, i.e. $Y(f)$.*

*(b) Show that if $y(t)$ is transmitted, the receiver can pass it through a replica of the system shown in Fig. 3 to obtain $m(t)$ back.*

*(c) How can the system be used as a simple scrambler to enhance communication privacy?*

## SOFTWARE QUESTIONS

## Question 6

**Validate the noise immunity of the DSB modulation using simulation results.**

*(a) Develop three MATLAB functions simulating a DSB modulator, an AWGN channel, and a DSB demodulator. The input arguments of the functions may include message, modulation, and noise parameters such as noise spectral density, carrier frequency, and so on.*

*(b) Use your developed functions to plot the SNR of the demodulator versus carrier amplitude and message bandwidth. How do you obtain the SNR?*

## BONUS QUESTIONS

## Question 7

**Return your answers by filling the LaTeXtemplate of the assignment.**

## EXTRA QUESTIONS

## Question 8

**Feel free to solve the following questions from the book *Fundamentals of Communication Systems* by J. Proakis and M. Salehi.**

1. **Chapter 3, question 3.**
2. **Chapter 3, question 4.**
3. **Chapter 3, question 8.**
4. **Chapter 3, question 9.**
5. **Chapter 3, question 17.**
6. **Chapter 6, question 1.**
7. **Chapter 6, question 3.**