Feedback — Communication Exercises

You submitted this homework on **Wed 3 Apr 2013 2:13 PM CDT -0500**. You got a score of **0.00** out of **9.00**. You can attempt again, if you'd like.

Question 1

Secret Communications
A system for hiding AM transmissions has the transmitter randomly switching between two carrier frequencies f_1 and f_2. "Random switching" means that one carrier frequency is used for some period of time, then switches to the other for a while, back to the first, etc. The receiver knows the carrier frequencies but *not* when the frequency switches occur. Consequently, the receiver must be designed to receive transmissions regardless of which carrier frequency is used. Assume the message has a baseband bandwidth of W. The channel attenuates the transmitted signal (attenuation constant α) and adds white noise of spectral height $\frac{N_0}{2}$.
How frequency separation between the two carrier frequencies must be employed?

Type an expression for the separation $|f_2 - f_1|$ in terms of f_1 (typed as `f1`), f_2 (typed as `f2`), α (typed as `a`), N_0 (typed as `N0`) and W (typed as `W`).

You entered:

Preview Help

Your Answer		Score	Explanation
	✘	0.00	Could not parse student submission
Total		0.00 / 1.00	

Question Explanation

If the carrier frequency separation $|f_2 - f_1|$ is not greater than $2W$, one carrier's message will “alias” into the other.

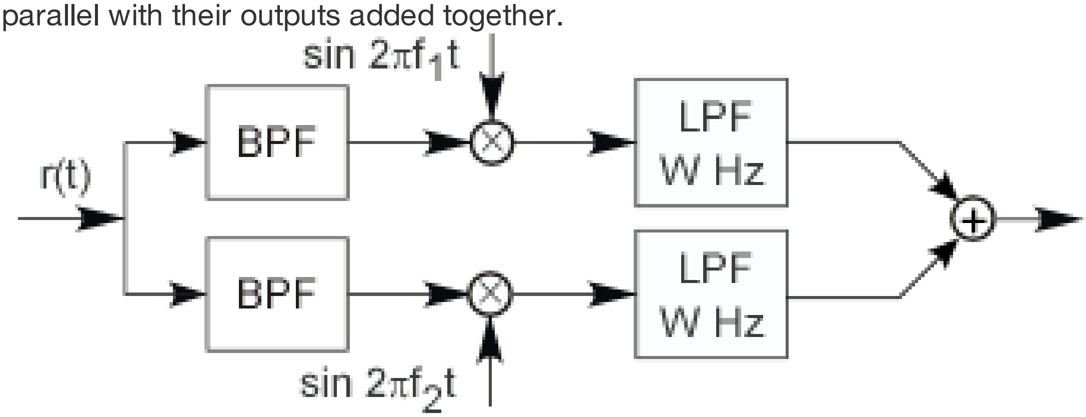
Question 2

What receiver should be designed?

Your Answer	Score	Explanation
Receiver tuned to f_1 in cascade with a receiver tuned to f_2.		
The receiver has to know the frequency switching pattern.		
Receiver tuned to $f_1 + f_2$.		
Receiver tuned to f_1 in parallel with a receiver tuned to f_2, with the two outputs added together.		
Total	0.00 / 1.00	

Question Explanation

We need two AM receivers, one tuned to f_1 and the other to f_2, operating in parallel with their outputs added together.



In this way, the output contains the message all the time regardless of the switching pattern.

Question 3

What is the signal-to-noise ratio for the demodulated signal?

Enter an expression for the signal-to-noise ratio in terms of f_1 (typed as `f1`), f_2 (typed as `f2`), α (typed as `a`), the transmitter's amplitude A (typed as `A`), N_0 (typed as `N0`) and W (typed as `W`). Type the message signal's power $\text{power}[m]$ as `Pm`.

You entered:

Preview Help

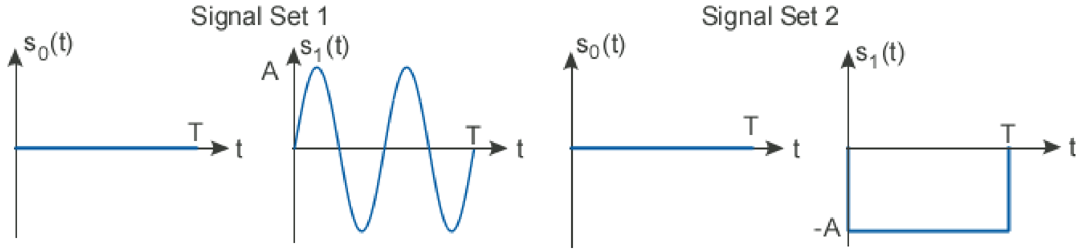
Your Answer		Score	Explanation
	✘	0.00	Could not parse student submission
Total		0.00 / 1.00	

Question Explanation

Only noise emerges from the mistuned receiver; the properly tuned receiver yields the message plus noise with identical characteristics to the standard receiver. Here, the signal power is $\alpha^2 A^2 \text{power}[m]/4$ and the noise power is $N_0 W/2$. The mistuned receiver's output noise power is the same as the tuned one: $N_0 W/2$. After adding the two outputs, the signal remains the same and the two noise signals add. The noise powers add, making the signal-to-noise ratio a factor of two smaller than the usual receiver's.

$$\frac{\alpha^2 A^2 \text{power}[m]/4}{2 \cdot N_0 W/2} = \frac{\alpha^2 A^2 \text{power}[m]}{4 N_0 W}$$

Question 4



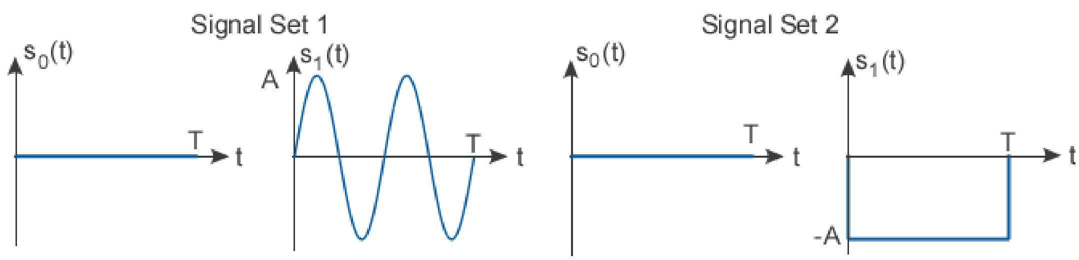
Which signal set will yield the smallest probability of error? Or will they yield the same performance?

Your Answer	Score	Explanation
Signal set 1		
Signal set 2		
They yield the same performance.		
Total	0.00 / 1.00	

Question Explanation

Signal set 2 has the largest value for the integral $\int_0^T [s_1(t) - s_0(t)]^2\, dt$. For signal set 1, we have $\frac{A^2}{2}$ while for the second we have A^2.

Question 5



Which signal set that the smallest bandwidth? Or are they the same?

Your Answer	Score	Explanation
Signal set 1		
Signal set 2		
They have the same bandwidth.		

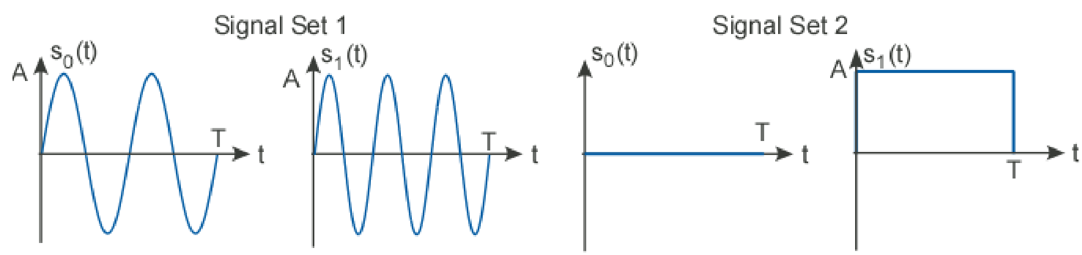
Total	0.00 / 1.00

Question Explanation

The 90% bandwidth of the first is $\frac{4}{T}$. Its alternating bit signal is a square wave with an offset added, all of which is multiplied by a sinusoid of frequency $\frac{2}{T}$. The second's alternating bit signal is just the square wave with an offset added, making its 90% bandwidth $\frac{2}{T}$.

Since signal set 2 yields the smallest P_e and has the smallest bandwidth, it is the clear choice.

Question 6



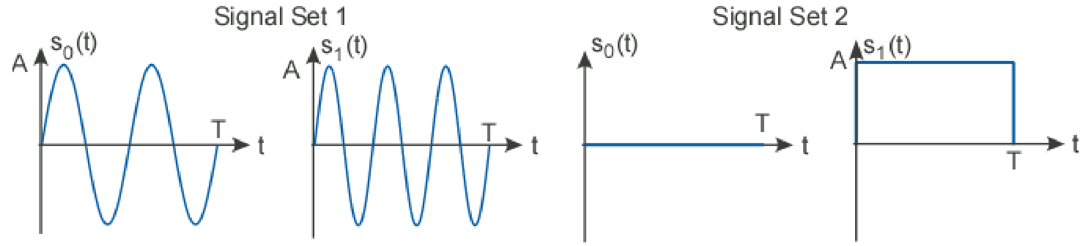
Which signal set will yield the smallest probability of error? Or will they yield the same performance?

Your Answer	Score	Explanation
Signal set 1		
Signal set 2		
They yield the same performance.		
Total	0.00 / 1.00	

Question Explanation

They have the same signal-difference energy of A^2, hence the same performance.

Question 7



Which signal set that the smallest bandwidth? Or are they the same?

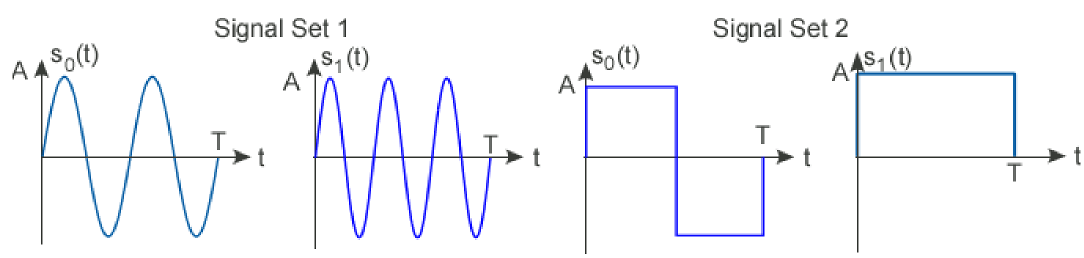
Your Answer	Score	Explanation
Signal set 1		
Signal set 2		
They have the same bandwidth.		
Total	0.00 / 1.00	

Question Explanation

The first is an FSK signal set with harmonic numbers k equal to 2 and 3. Its bandwidth is $\frac{2}{T}$. Therefore, the two signals have the same 90% bandwidth.

The same performance and the same bandwidth means they are equivalent. Choosing between them comes down to channel characteristics: can you use a baseband signal set (Signal Set 2) or not?

Question 8



Which signal set will yield the smallest probability of error? Or will they yield the same performance?

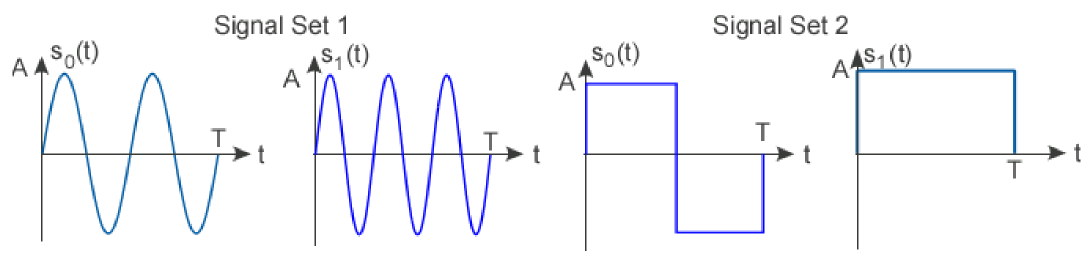
Your Answer	Score	Explanation

Signal set 1	
Signal set 2	
They yield the same performance.	
Total	0.00 / 1.00

Question Explanation

Signal set 2 has the largest signal difference energy ($2A^2$).

Question 9



Which signal set that the smallest bandwidth? Or are they the same?

Your Answer	Score	Explanation
Signal set 1		
Signal set 2		
They have the same bandwidth.		
Total	0.00 / 1.00	

Question Explanation

The first is an FSK signal set with harmonic numbers k equal to 2 and 3. Its bandwidth is $\frac{2}{T}$.
For signal set 2, the highest frequency signal is repeating zeros, *not* an alternating sequence. That makes its 90% bandwidth equal to its third harmonic: $\frac{3}{T}$.
Signal set 1 has the smallest bandwidth.

Choosing between these two signal sets is difficult: the second yields the best performance but requires a wider bandwidth channel. Again, the channel's characteristics come into play: what kind of filtering does it apply to transmitted signals?