1. A DS/SS system is used to combat multipath. The path length of the multipath wave is 100m longer than that of the direct wave. The delay experienced by the multipath wave compared to direct wave is:

   (2 marks)

   (a) 0.167 µs
   (b) 0.333 µs
   (c) 0.667 µs
   (d) 0.667 ms

2. Referring question 1, the minimum chip rate necessary to reject the multipath interference is:

   (1 mark)

   (a) 6 Mchips/s
   (b) 1.5 Mchips/s
   (c) 3 Mchips/s
3. Consider a spread spectrum system using a maximal linear codes with period $T = T_s$ and $N = 100$ chips per symbol. Assume that the synchronizer has a delay offset $\tau = 0.5T_c$ relative to the LOS signal component to which it is synchronized. The power of this signal component reduced by this timing offset is:

Note: $T_s$ is the symbol time and $T_c$ is the chip time.

Hint: The autocorrelation, $\rho_c(\tau) = 1 - \frac{|\tau(1 + \frac{1}{N})}{T_c}$

(a) $-1.55$ dB
(b) $-12.22$ dB
(c) $-3.05$ dB
(d) $-6.11$ dB

4. The Maximal length sequence generated by a shift register of length, $n = 10$ is used in the generation of Kasami codes. The magnitude of the worst-case cross-correlation for small Kasami sequences is:

Hint: The small Kasami sequences take on the following three cross-correlation values.

$$\rho_c(\tau) = \begin{cases} \frac{-1}{N} \\ \frac{-s(n)}{N} \\ \frac{1}{N} [s(n) - 2] \end{cases}$$

Note: $N$ is the length of the maximal sequence and $s(n) = 2^{n/2} + 1$.

(a) 0.064
(b) 0.032
(c) 0.016
(d) 0.008
5. Referring to question 4, the magnitude of the worst-case cross-correlation for large Kasami sequences is:

Hint: The large Kasami sequences take on the following five cross-correlation values.

\[
\rho_c(\tau) = \begin{cases} 
\frac{-1}{N} \\
\frac{1}{N} \left( -1 \pm \frac{2^\frac{n}{2} \pm 1}{2} \right) \\
\frac{1}{N} \left( -1 \pm \left( 2^\frac{n}{2} + 1 \right) \right) 
\end{cases}
\]

Note: N is the length of the maximal sequence.

(2 marks)

(a) 0.075
(b) 0.672
(c) 0.033
(d) 0.231

6. The decrement rate of cross-correlation function \((\phi_{\text{max}})\) for Kasami code of length, \(N = 127\) is:

Hint: For Kasami codes, \(\phi_{\text{max}}\) decreases as \(\frac{1}{\sqrt{N}}\) for large N.

(2 marks)

(a) 0.089
(b) 0.023
(c) 0.375
(d) 0.456

7. The Maximal length sequence generated by a shift register of length \(n\) is used in the generation of Gold codes. The preferred sequences are chosen so that Gold codes have the following three cross-correlation values.

\[
\rho_c(\tau) = \begin{cases} 
\frac{-1}{N} \\
- t \left( N \right) \quad \text{(or)} \quad - \frac{t(n)}{N} \\
ten \left( N \right) - 2 \quad \frac{1}{N} \left[ t \left( n \right) - 2 \right]
\end{cases}
\]
The magnitude of the worst-case cross-correlation for n = 10 is:

Hint: N is the length of the Gold sequence and t(N), t(n) are functions with respect to N and n respectively. The function,

\[ t(n) = \begin{cases} 
2^{(n+1)/2} + 1; & \text{if } n \text{ is odd} \\
2^{(n+2)/2} + 1; & \text{if } n \text{ is even}
\end{cases} \]

(2 marks)

(a) 0.064
(b) 0.051
(c) 0.646
(d) 0.512

8. Referring to question 7, the magnitude of the worst-case cross-correlation for n = 9 is:

(2 marks)

(a) 0.657
(b) 0.098
(c) 0.112
(d) 0.065

9. Referring to question 7, if N = 128, the decrement rate of t(N) is:

(2 marks)

(a) 0.887
(b) 0.125
(c) 0.177
(d) 0.442

10. Referring to question 7, if N = 127, the decrement rate of t(N) is:

(2 marks)
(a) 0.316
(b) 0.125
(c) 0.765
(d) 0.246