22F-COM SCI-118-LEC-1 Homework 1

CHARLES ZHANG

TOTAL POINTS

53 / 53

QUESTION 1

9 pts

1.1 1.A **2 / 2**

✓ **+ 2 pts** Attamped

+ 0 pts Empty

1.2 1.B.1 **1 / 1**

✓ **+ 1 pts** Attamped

+ 0 pts Empty

1.3 1.B.2 **2 / 2**

✓ **+ 2 pts** Attamped

+ 0 pts Empty

1.4 1.B.3 **2 / 2**

✓ **+ 2 pts** Correct

+ 0 pts Empty

1.5 1.B.4 **2 / 2**

✓ **+ 2 pts** Attamped

+ 0 pts Empty

QUESTION 2

6 pts

2.1 2.1 **2 / 2**

✓ **+ 2 pts** Correct

+ 0 pts Empty

2.2 2.2 **2 / 2**

✓ **+ 2 pts** Attamped

+ 0 pts Empty

2.3 2.3 **2 / 2**

✓ **+ 2 pts** Correct

+ 0 pts Empty

QUESTION 3

38 pts

3.1 3.1 **4 / 4**

✓ **+ 4 pts** Full marks for Correct graph

+ 2 pts An attempt that seems to have tried

+ 0 pts Empty

3.2 3.2 **4 / 4**

✓ **+ 4 pts** Full marks for Correct offset

+ 2 pts An attempt that seems to have tried

+ 0 pts Empty

3.3 3.3 **22 / 22**

✓ **+ 22 pts** Full marks for Correct lag table and graph with correct sampling instants

+ 20 pts Correct lag table but with unclear graph

+ 20 pts Only have graph without the lag table or lag values are not correct

+ 18 pts Only have one unlabeled graph

+ 15 pts An attempt that seems to have tried

+ 0 pts Empty

3.4 3.4 **4 / 4**

✓ **+ 4 pts** Full marks for Correct answer

+ 2 pts An attempt that seems to have tried

+ 0 pts Empty

3.5 3.5 **4 / 4**

✓ **+ 4 pts** Full marks for Correct sampling bits and expiations

+ 2 pts An attempt that seems to have tried

+ 0 pts Empty

CS 118 Assignment 1

Charles Zhang

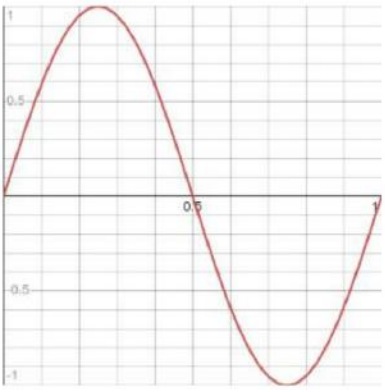
October 11, 2022

Problem 1

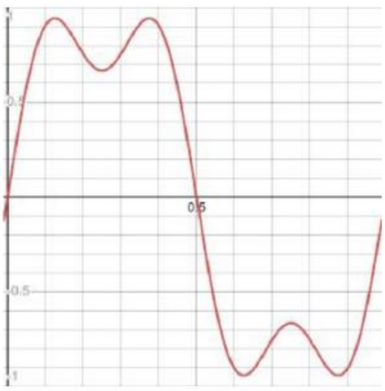
A) By Chain Rule we know that, when integrating $\sin(2\pi nt)$, we arrive at a coefficient of $\frac{1}{2\pi n}$ which is inversely proportional to n, since 2π is a constant.

B1)

$\sin(2\pi t)$:



$\sin(2\pi t) + \frac{\sin(6\pi t)}{3}$:



1.1 1.A 2 / 2

✓ **+ 2 pts** Attamped

+ 0 pts Empty

CS 118 Assignment 1

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Problem 1

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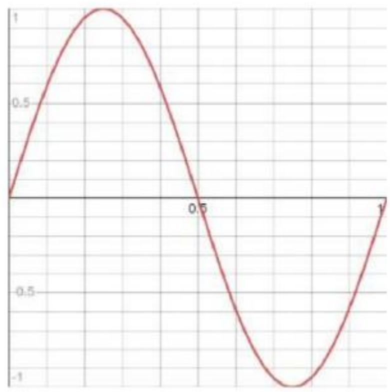
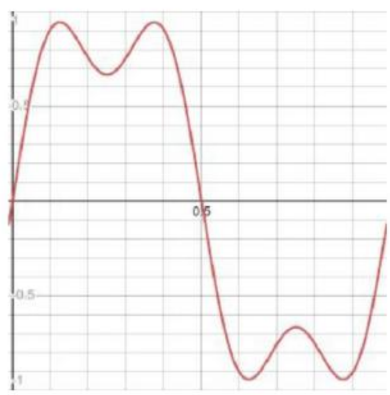
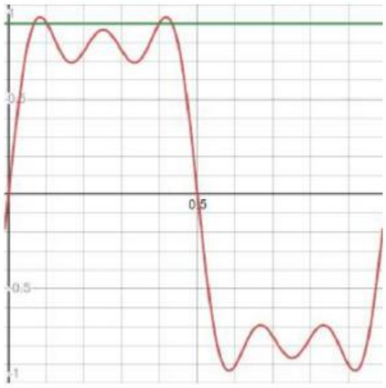
$\sin(2\pi t)$:



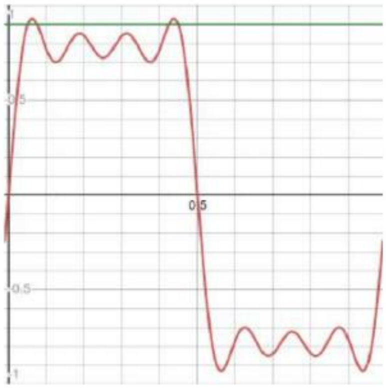
$\sin(2\pi t) + \frac{\sin(6\pi t)}{3}$:



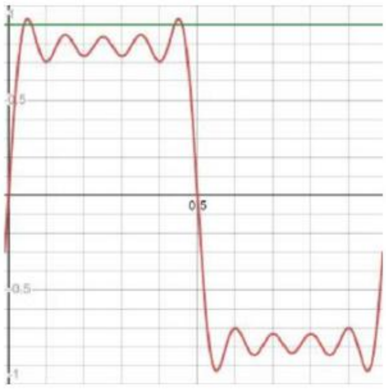
$\sin(2\pi t) + \frac{\sin(6\pi t)}{3} + \frac{\sin(10\pi t)}{5}$:



$\sin(2\pi t) + \frac{\sin(6\pi t)}{3} + \frac{\sin(10\pi t)}{5} + \frac{\sin(14\pi t)}{7}$:



$\sin(2\pi t) + \frac{\sin(6\pi t)}{3} + \frac{\sin(10\pi t)}{5} + \frac{\sin(14\pi t)}{7} + \frac{\sin(18\pi t)}{9}$:



1.2 1.B.1 **1 / 1**

✓ **+ 1 pts** Attamped

+ 0 pts Empty

B2)

$\sin(2\pi t)$:

$$\boxed{1\text{Hz}}$$

$\sin(2\pi t) + \frac{\sin(6\pi t)}{3}$:

$$\boxed{3\text{Hz}}$$

$\sin(2\pi t) + \frac{\sin(6\pi t)}{3} + \frac{\sin(10\pi t)}{5}$:

$$\boxed{5\text{Hz}}$$

$\sin(2\pi t) + \frac{\sin(6\pi t)}{3} + \frac{\sin(10\pi t)}{5} + \frac{\sin(14\pi t)}{7}$:

$$\boxed{7\text{Hz}}$$

$\sin(2\pi t) + \frac{\sin(6\pi t)}{3} + \frac{\sin(10\pi t)}{5} + \frac{\sin(14\pi t)}{7} + \frac{\sin(18\pi t)}{9}$:

$$\boxed{9\text{Hz}}$$

B3)

$\sin(2\pi t)$:

$$\frac{|1 - 1.2732|}{1} \times 100 = \boxed{27.32\%}$$

1.3 1.B.2 2 / 2

✓ + **2 pts** Attamped

+ **0 pts** Empty

B2)

$\sin(2\pi t)$:

$$\boxed{1\text{Hz}}$$

$\sin(2\pi t) + \frac{\sin(6\pi t)}{3}$:

$$\boxed{3\text{Hz}}$$

$\sin(2\pi t) + \frac{\sin(6\pi t)}{3} + \frac{\sin(10\pi t)}{5}$:

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B3)

$\sin(2\pi t)$:

$$\frac{|1 - 1.2732|}{1} \times 100 = \boxed{27.32\%}$$

$\sin(2\pi t) + \frac{\sin(6\pi t)}{3}$:

$$\frac{|1 - 1.2004|}{1} \times 100 = \boxed{20.04\%}$$

$\sin(2\pi t) + \frac{\sin(6\pi t)}{3} + \frac{\sin(10\pi t)}{5}$:

$$\frac{|1 - 0.8821|}{1} \times 100 = \boxed{11.79\%}$$

$\sin(2\pi t) + \frac{\sin(6\pi t)}{3} + \frac{\sin(10\pi t)}{5} + \frac{\sin(14\pi t)}{7}$:

$$\frac{|1 - 0.8917|}{1} \times 100 = \boxed{10.83\%}$$

$\sin(2\pi t) + \frac{\sin(6\pi t)}{3} + \frac{\sin(10\pi t)}{5} + \frac{\sin(14\pi t)}{7} + \frac{\sin(18\pi t)}{9}$:

$$\frac{|1 - 0.8959|}{1} \times 100 = \boxed{10.41\%}$$

B4)

$\sin(2\pi t)$:

$$\boxed{0.18\text{s}}$$

$\sin(2\pi t) + \frac{\sin(6\pi t)}{3}$:

$$\boxed{0.0985\text{s}}$$

1.4 1.B.3 2 / 2

✓ + 2 pts Correct

+ 0 pts Empty

$\sin(2\pi t) + \frac{\sin(6\pi t)}{3}$:

$$\frac{|1 - 1.2004|}{1} \times 100 = \boxed{20.04\%}$$

$\sin(2\pi t) + \frac{\sin(6\pi t)}{3} + \frac{\sin(10\pi t)}{5}$:

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$$\frac{|1 - 0.8917|}{1} \times 100 = \boxed{10.83\%}$$

$\sin(2\pi t) + \frac{\sin(6\pi t)}{3} + \frac{\sin(10\pi t)}{5} + \frac{\sin(14\pi t)}{7} + \frac{\sin(18\pi t)}{9}$:

$$\frac{|1 - 0.8959|}{1} \times 100 = \boxed{10.41\%}$$

B4)

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$$\boxed{0.18\text{s}}$$

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$$\boxed{0.0985\text{s}}$$

$\sin(2\pi t) + \frac{\sin(6\pi t)}{3} + \frac{\sin(10\pi t)}{5}$:

$$\boxed{0.0674\text{s}}$$

$\sin(2\pi t) + \frac{\sin(6\pi t)}{3} + \frac{\sin(10\pi t)}{5} + \frac{\sin(14\pi t)}{7}$:

$$\boxed{0.051\text{s}}$$

$\sin(2\pi t) + \frac{\sin(6\pi t)}{3} + \frac{\sin(10\pi t)}{5} + \frac{\sin(14\pi t)}{7} + \frac{\sin(18\pi t)}{9}$:

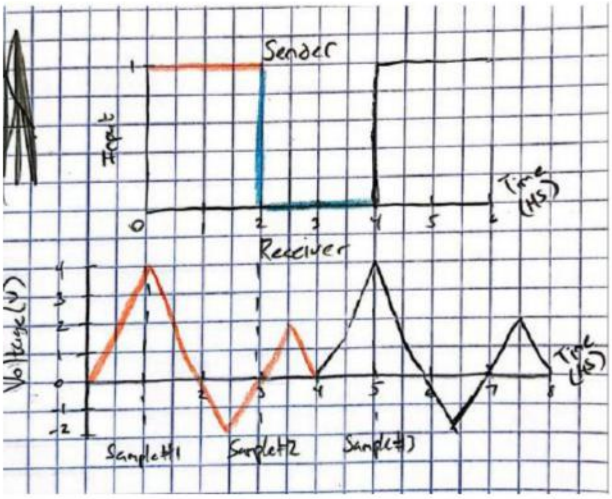
$$\boxed{0.041\text{s}}$$

1.5 1.B.4 **2 / 2**

- ✓ **+ 2 pts** Attamped
- **+ 0 pts** Empty

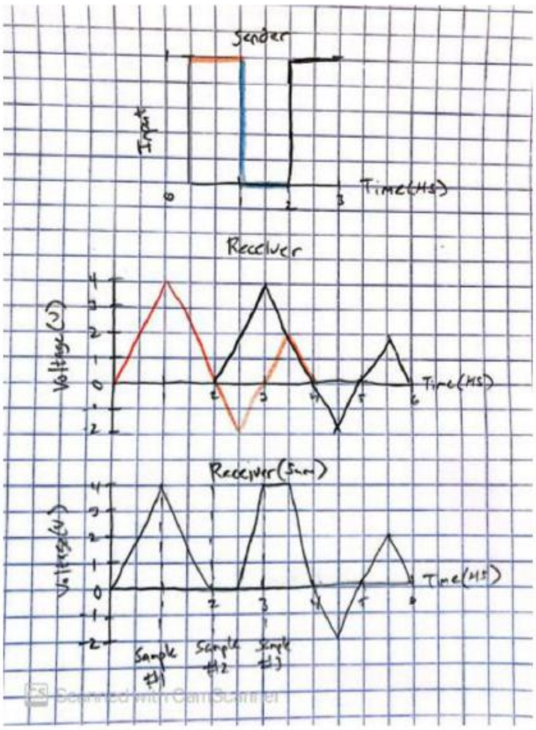
Problem 2

2.1)



The measured outputs are 4V at $1\mu s$, 0V at $3\mu s$, and 4V at $5\mu s$. These translate to output bits of `1`, `0`, and `1`.

2.2)



The measured outputs are 4V at $1\mu s$, 0V at $2\mu s$, and 4V at $3\mu s$. These translate to output bits of `1`, `0`, and `1`.

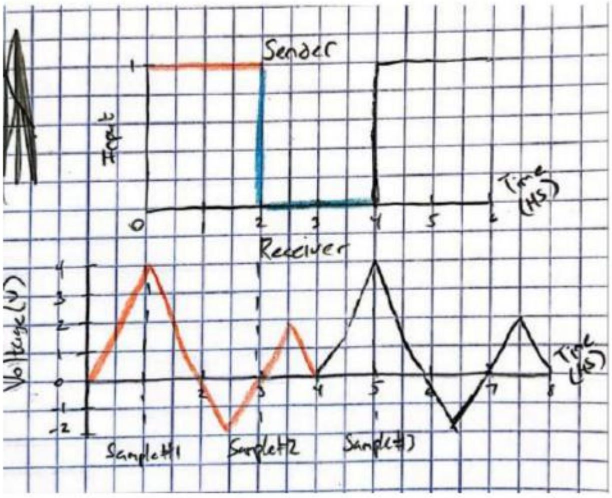
2.1 2.1 2 / 2

✓ + 2 pts Correct

+ 0 pts Empty

Problem 2

2.1)



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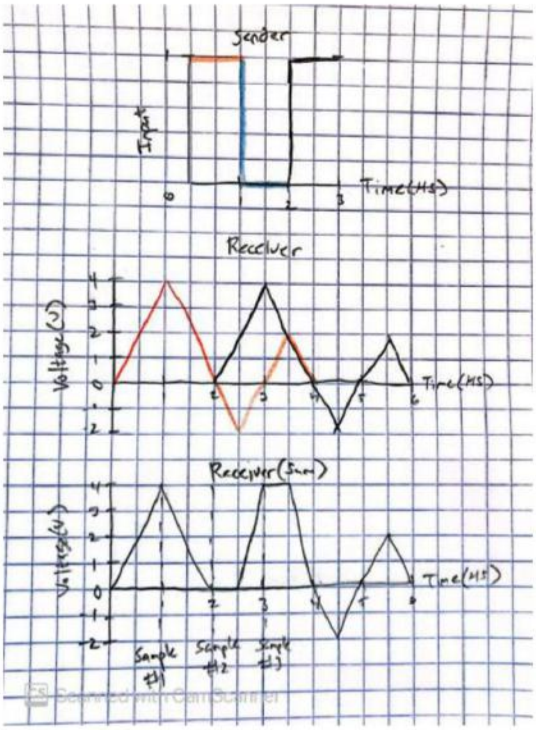


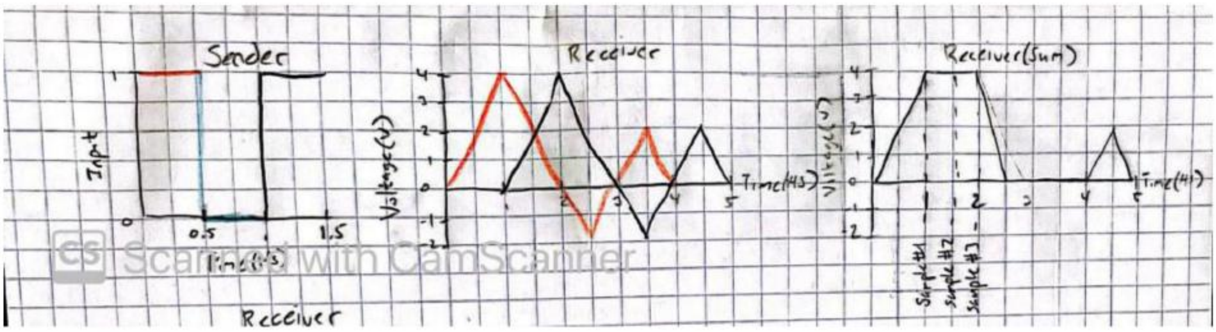
The measured outputs are 4V at $1\mu s$, 0V at $2\mu s$, and 4V at $3\mu s$. These translate to output bits of `1`, `0`, and `1`.

2.2 2.2 **2 / 2**

✓ **+ 2 pts** Attamped

+ 0 pts Empty

2.3)



The measured outputs are 4V at $1\mu s$, 4V at $1.5\mu s$, and 4V at $2\mu s$. These translate to output bits of 1, 1, and 1, showing clear ISI.

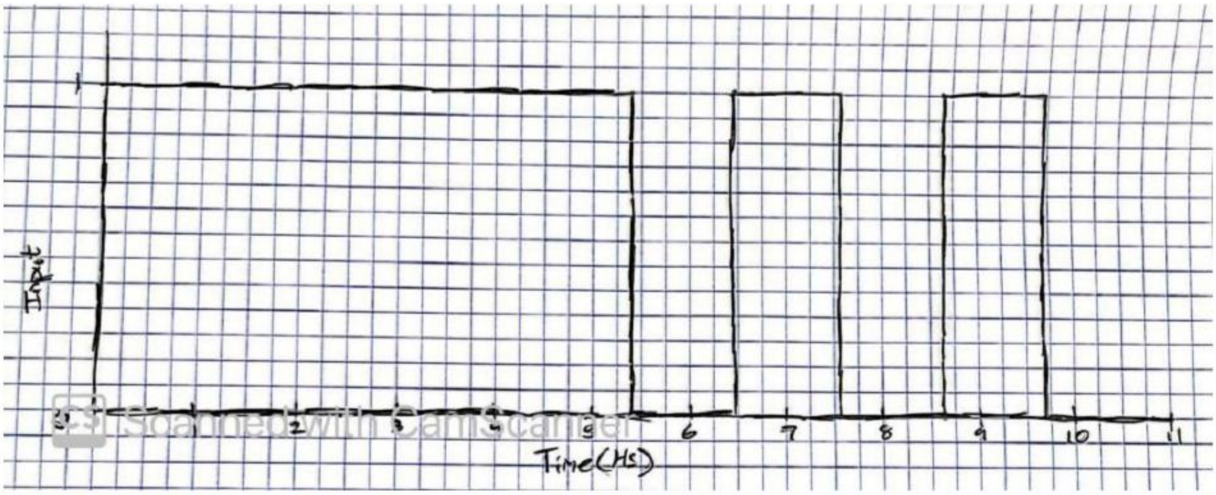
2.3 2.3 **2 / 2**

✓ **+ 2 pts** Correct

+ 0 pts Empty

Problem 3

3.1)



3.2)

Knowing that the sender is sending 8% slower, we know that the actual middle of bits occur at $0.54\mu s$, $1.62\mu s$, $2.7\mu s$... We also know that, without clock recovery, the receiver samples at $0.5\mu s$, $1.5\mu s$, $2.5\mu s$... Following this pattern, we can calculate that the middle of the 10th bit occurs at $10.26\mu s$ and is sampled at $9.5\mu s$, which tells us the sampling is off by:

$$|10.26\mu s - 9.5\mu s| = \boxed{0.76\mu s}$$

3.1 3.1 **4 / 4**

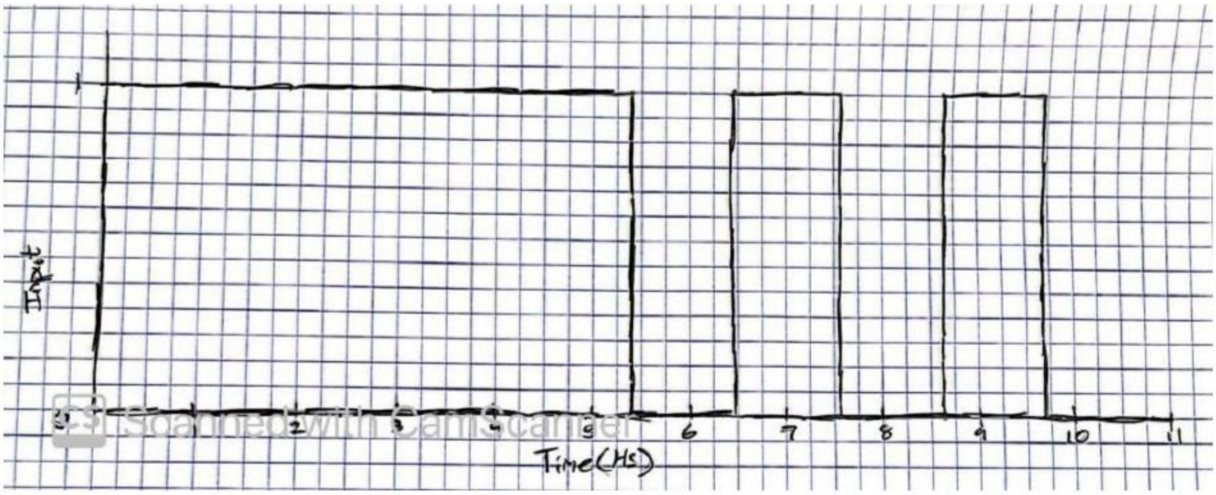
✓ **+ 4 pts** Full marks for Correct graph

+ 2 pts An attempt that seems to have tried

+ 0 pts Empty

Problem 3

3.1)



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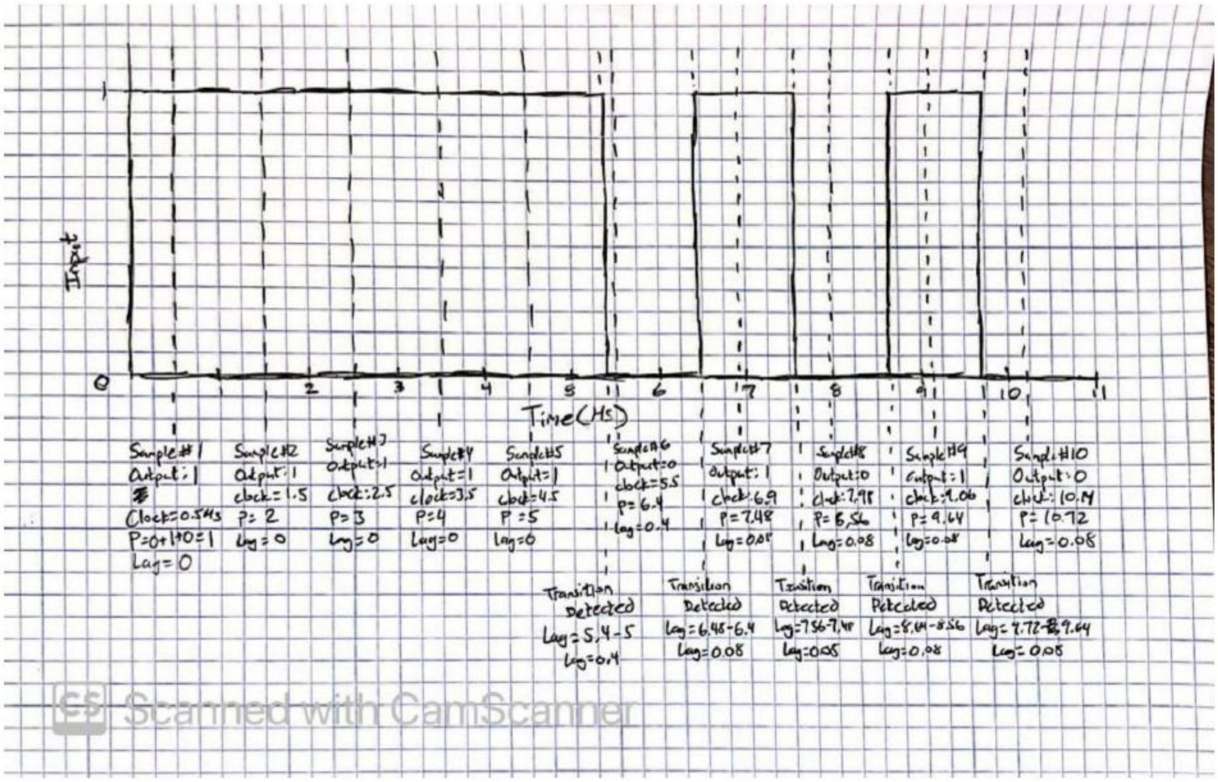
$$|10.26\mu\text{s} - 9.5\mu\text{s}| = \boxed{0.76\mu s}$$

3.2 3.2 **4 / 4**

- ✓ **+ 4 pts** **Full marks for Correct offset**
- **+ 2 pts** An attempt that seems to have tried
- **+ 0 pts** Empty

3.3)



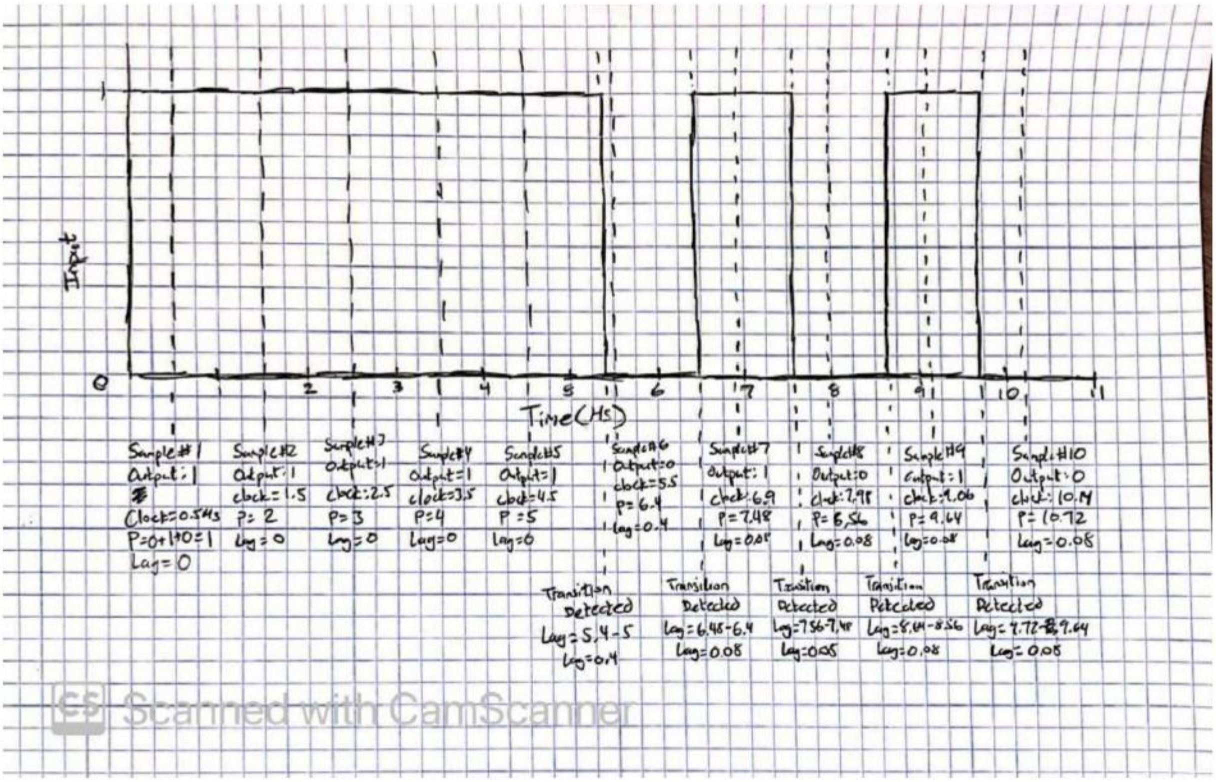
3.4)

A sharp noise spike at $0.3\mu s$ wouldn't have any affect on sampling times or output since the clock recovery algorithm we use doesn't begin sampling or searching for transitions until $0.5\mu s$. At $0.3\mu s$, we would still be waiting for the initial $\frac{T}{2}$ timer to expire.

3.3 3.3 **22 / 22**

- ✓ **+ 22 pts** **Full marks for Correct lag table and graph with correct sampling instants**
- **+ 20 pts** Correct lag table but with unclear graph
- **+ 20 pts** Only have graph without the lag table or lag values are not correct
- **+ 18 pts** Only have one unlabeled graph
- **+ 15 pts** An attempt that seems to have tried
- **+ 0 pts** Empty

3.3)



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3.4 3.4 **4 / 4**

✓ **+ 4 pts** Full marks for Correct answer

+ 2 pts An attempt that seems to have tried

+ 0 pts Empty

3.5)

At the time the spike occurs, we have $P = 3$ and $A = 2.7$, resulting in $lag = -0.3$. In the context of this algorithm, a negative lag means that the actual transition occurred before the predicted transition, or that the sender's clock is faster than the receiver's. As a result, the receiver will begin to sample earlier after detecting this noise, when it should be trying to sample later, since the sender's clock is actually slower than the receiver's. The new samples are as follows:

Sample #	Output	Clock	P	Lag
1	`1`	0.5	1	0
2	`1`	1.5	2	0
3	`1`	2.5	3	0
4	`1`	3.5	3.7	-0.3
5	`1`	4.2	4.4	-0.3
6	`1`	4.9	5.1	-0.3
7	`0`	5.6	6.4	0.3
8	`1`	6.9	7.48	0.08
9	`0`	7.98	8.56	0.08
10	`1`	9.06	9.64	0.08

As seen by the values in the table, samples #4-6 are performed too early, resulting in an extra `1` being sampled in this time frame, and the following `0101` being shifted 1 bit to the right, while the final `0` bit is dropped due to the extra sampling. The receiver manages to recover using the actual transitions from the input bits, but not before this error is introduced.

3.5 3.5 **4 / 4**

✓ **+ 4 pts** **Full marks for Correct sampling bits and expiations**

+ 2 pts An attempt that seems to have tried

+ 0 pts Empty