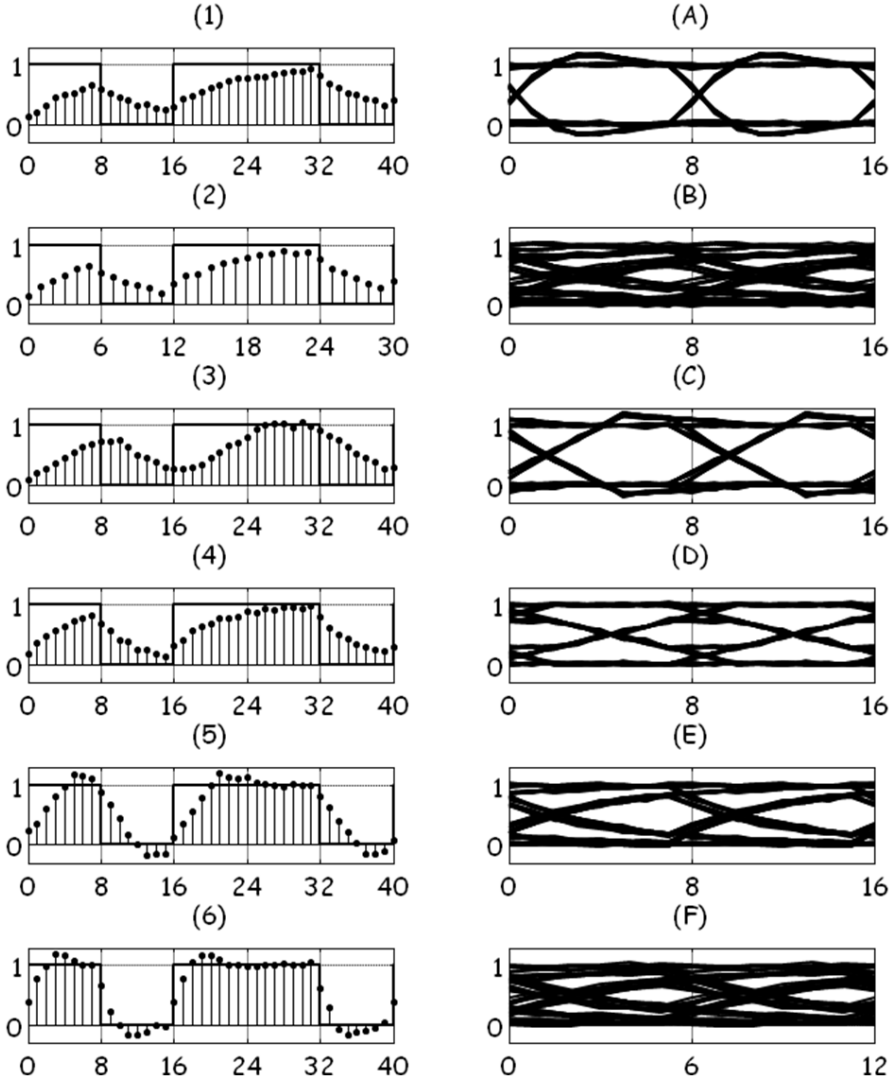
INTERSYMBOL INTERFERENCE AND EQUALIZATION

SECTION 3 QUESTION 1 (2 points possible)

In the diagram below, the left column shows the output of different communication channels to the first five bits of a random bit input waveform (solid line). The right column shows the eye diagram resulting from overlaying plots of 2*SPB+1 samples for the same channels but in random order.



Match the channels 1 through 6 with their corresponding eye diagrams labelled A to F.

Please input a sequence of letters indicating which eye diagram corresponds to the channel 1 through 6. For example, if eye diagram A corresponds to Channel 1, B to 2, C to 3, D to 4, E to 5 and F to 6, input ABCDEF without any whitespaces.

FBEDCA

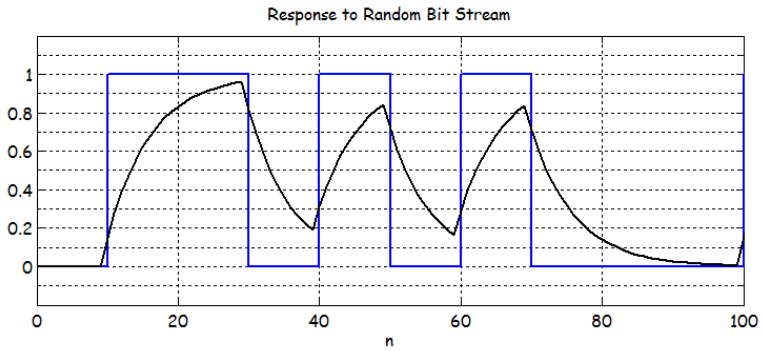
Answer: BFDECA

Hide Answer *You have used 1 of 1 submissions*

Help

SECTION 3 QUESTION 2 INTRODUCTION

The figure below shows the response of a communication channel (in black) to a random 10-bit sequence transmitted with 10 samples per bit (shown in blue).



SECTION 3 QUESTION 2 PART A (2 points possible)

Estimate the height of the eye in the eye diagram for this channel assuming a bit time of 10 samples per bit.

Please select the correct answer.

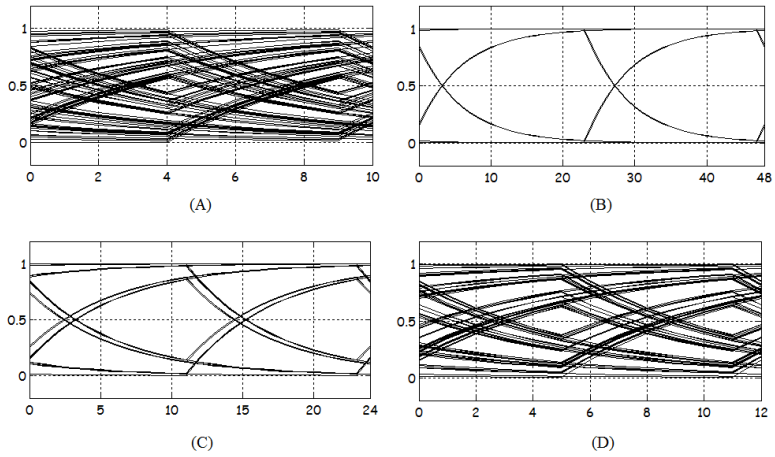
- 1
- 0.8 ✗
- 0.6 ✓
- 0.4
- 0.2

Hide Answer *You have used 1 of 1 submissions*

SECTION 3 QUESTION 2 PART B (2 points possible)

Which one of the following four eye diagrams corresponds to the eye diagram generated when the bit time is 12 samples per bit?

Help



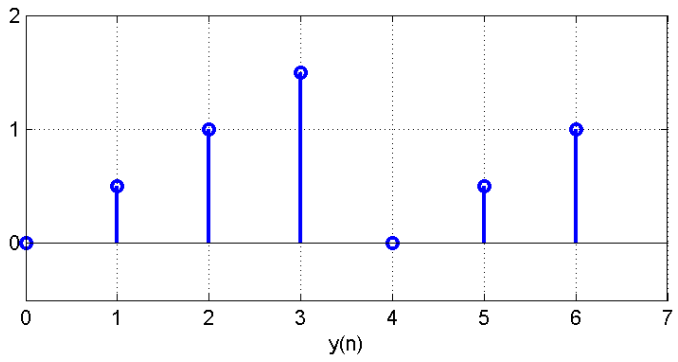
Please select the correct answer.

- A
- B
- C ✔
- D ✖

Hide Answer *You have used 1 of 1 submissions*

SECTION 3 QUESTION 3 (2 points possible)

Consider the following waveform.



Which of the following is a **recursive** model for this waveform. Note that "mod" stands for the modulo operator, i.e. a mod n is the remainder after dividing a by n.

Please select the correct answer.

- y(n) = (n mod 4)/2 ✗
- y(0) = 0, y(n) = (y(n-1) + 1) mod 4
- y(0) = 0, y(n) = ((y(n-1) + 1) mod 4)/2
- y(0) = 0, y(n) = (y(n-1) + 0.5) mod 2 ✓

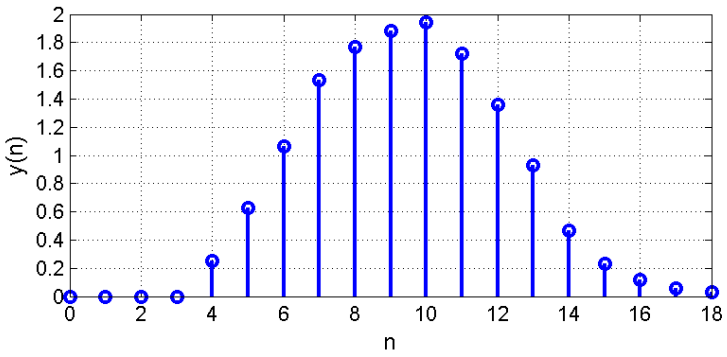
Help

Hide Answer

You have used 1 of 1 submissions

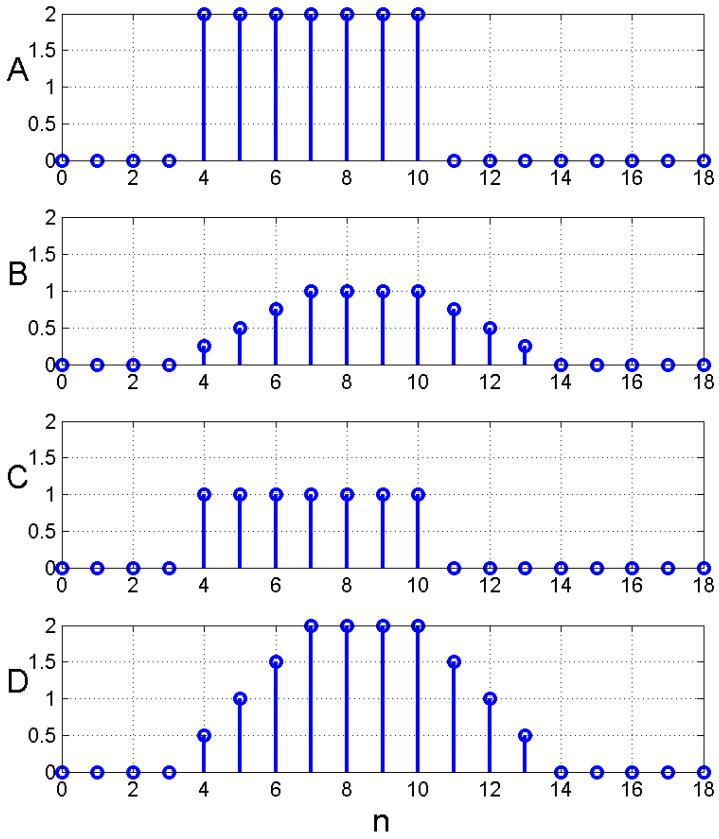
SECTION 3 QUESTION 4 (2/2 points)

Consider the waveform shown below, which was observed at the output of a channel whose step response is given by $s(n) = (2 - (0.5)^n)u(n)$ where $u(n)$ is the unit step function.



Which of the following waveforms corresponds to the input of the channel that generated this output?

Help



Please select the correct answer.

- A
- B ✔
- C
- D

Show Answer *You have used 1 of 1 submissions*

SECTION 3 MATLAB QUESTION (3/3 points)

In this MATLAB question, your job is to improve the performance of a communication system.

The initial code in the code window first generates the waveform received at the output of a channel in response to a transmitted waveform. The transmitted waveform was obtained by taking a random 50 bit binary sequence, framing it by adding one start bit to the beginning, encoding the resulting bitstream at 20 samples per bit (SPB), and then adding a training sequence consisting of 500 0's, 500 1's and 500 0's. Since the framed bit sequence occurs immediately after the training sequence, the start bit always begins at sample index 1501. The code then computes a bit decision threshold using the training sequence and then decodes the bit sequence from the received waveform by comparing it to the threshold. The received bit sequence is stored in the vector **bsout**. The function **check_final_03** compares the recieved bit

stream to the transmitted bit stream, which is identified by a code contained in **bscode**.

If you run the code as presented, MATLAB will return a figure window, which compares the transmitted and received bit sequences. These will be identical, indicating that the communication channel works properly. However, due to intersymbol interference, the communication system does not work at faster bit rates.

Help

Increase the bit rate by changing the variable SPB in the first line of code to 3 and re-run the code. The transmitted and received bit streams now differ.

Your job is to modify the code to improve the performance of this communication system so that it works for **SPB** = 3. There is no additive noise in this system, but it turns out that the channel can be modeled by the following recursive equation

$$y(n) = a \cdot y(n-1) + k \cdot (1-a) \cdot x(n)$$

where $x(n)$ is the input to the channel, $y(n)$ is the output of the channel, and $a = 0.88$ and $k = 0.7$. In modifying the system, do not change the first or last lines of code, and do not change the values of **rx_wave** or **bscode**.

Since the bit sequence is random, run your code several times to ensure that it works before submitting your work by clicking on the **Check** button.

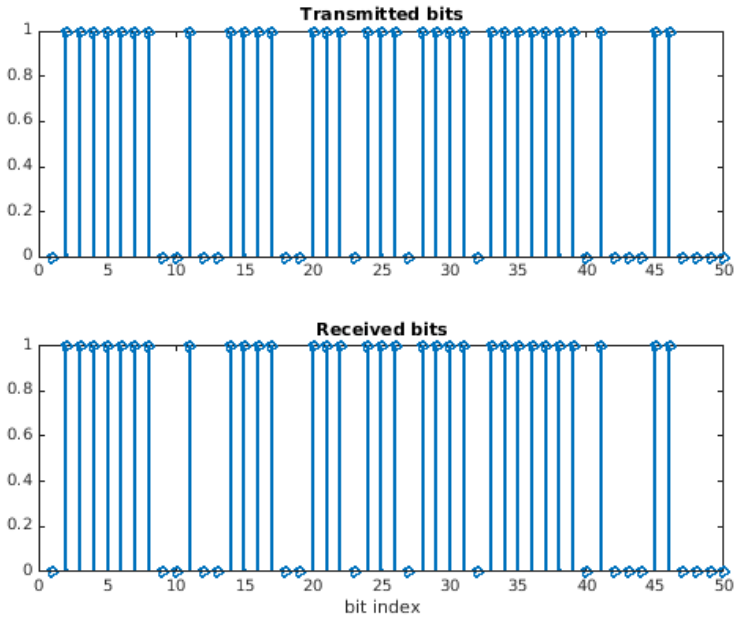
IMPORTANT: Make sure that **SPB = 3** before submitting your work!

```
SPB = 3; % samples per bit, change this to 3

% get response to random sequence of 50-bits transmitted at SPB samples per
% bit.  Do not change the values of rx_wave or bscode.
[rx_wave,bscode] = rxwave_final_03(SPB);

start_ind = 1501; % for convenience the location of the start bit is fixed
ind = start_ind + 2*SPB - 1 + SPB*[0:49];

thresh = (max(rx_wave)+min(rx_wave))/2;
%can't change rx_wave OR bscode, but you can change bsout
eq_wave = zeros(size(rx_wave)); % initialize equalizer output
len_rxwave = length(rx_wave);
for i = 1:len_rxwave
    if (i > 1)
```

Correct

```
% replace the two lines starting with "thresh = ...." with the following
k = 0.7;
a = 0.88;                       % parameter of channel model
len_wave = length(rx_wave);           % find length of input
eq_wave(1) = (1/k)*rx_wave(1)/(1-a);  % assume rx_wave(0)=0;
for n = 2:len_wave,
    eq_wave(n) = (1/k)*(rx_wave(n)-a*rx_wave(n-1))/(1-a);
end
thresh = (max(eq_wave)+min(eq_wave))/2;
bsout = eq_wave(ind) > thresh;
```

Figure 1



Hide Answer

You have used 1 of 5 submissions