# AV343 Communication Systems Lab: 1

## SIMULATION OF A BASEBAND COMMUNICATION SYSTEM

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(SEMESTER VI)

Generation of bits: The source is assumed to produce a stream of bits. The bits are usually modelled as an independent and identically distributed random process with the probability of a bit being 1 being 0.5. Generate a random sequence of bits of length $N$ (input) satisfying this property.

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CODE

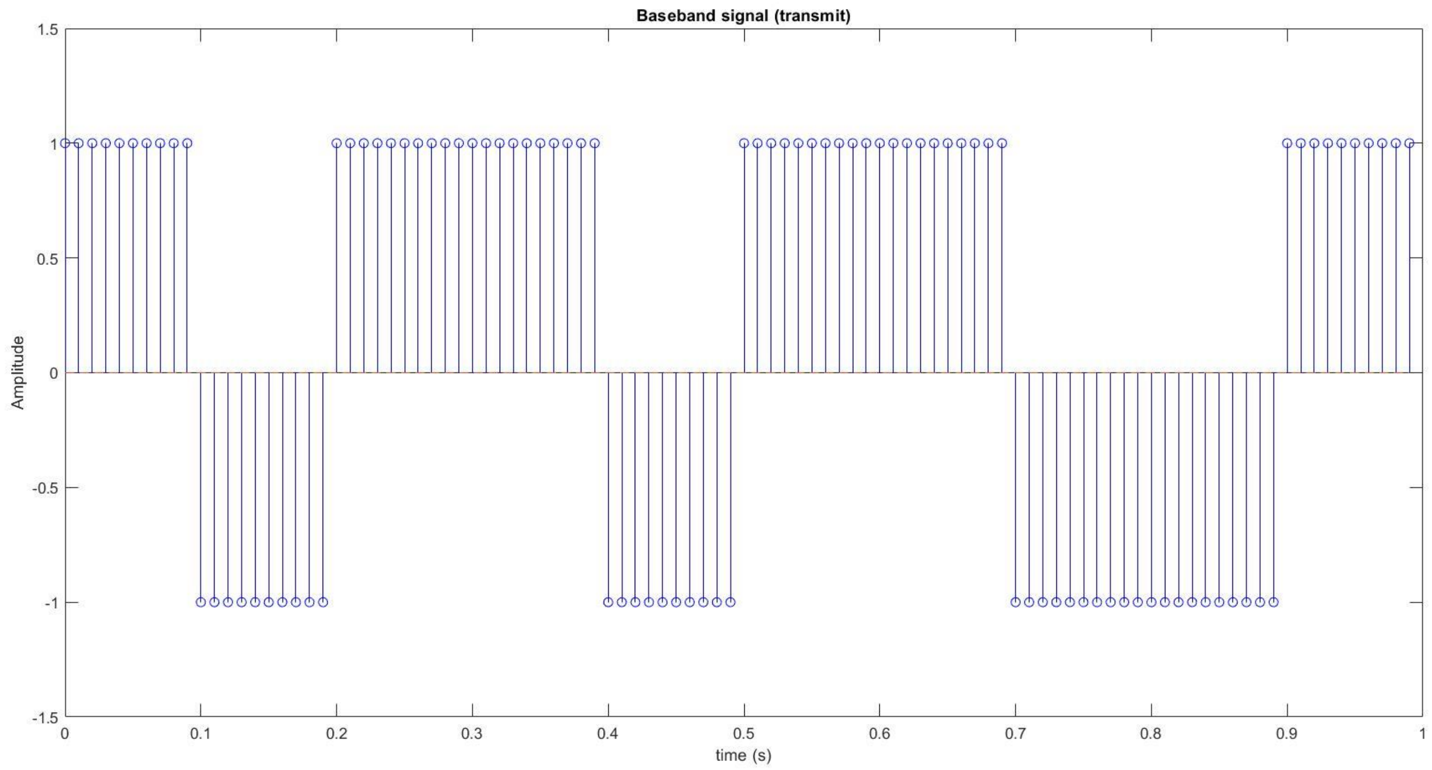
```
function bits = randomBits(N)
bits = randi([0, 1], 1, N);
disp("Bits generated: ");
disp(num2str(bits));
end
```

```
%% Generating Bits
N = 10;
bits = randomBits(N);
```

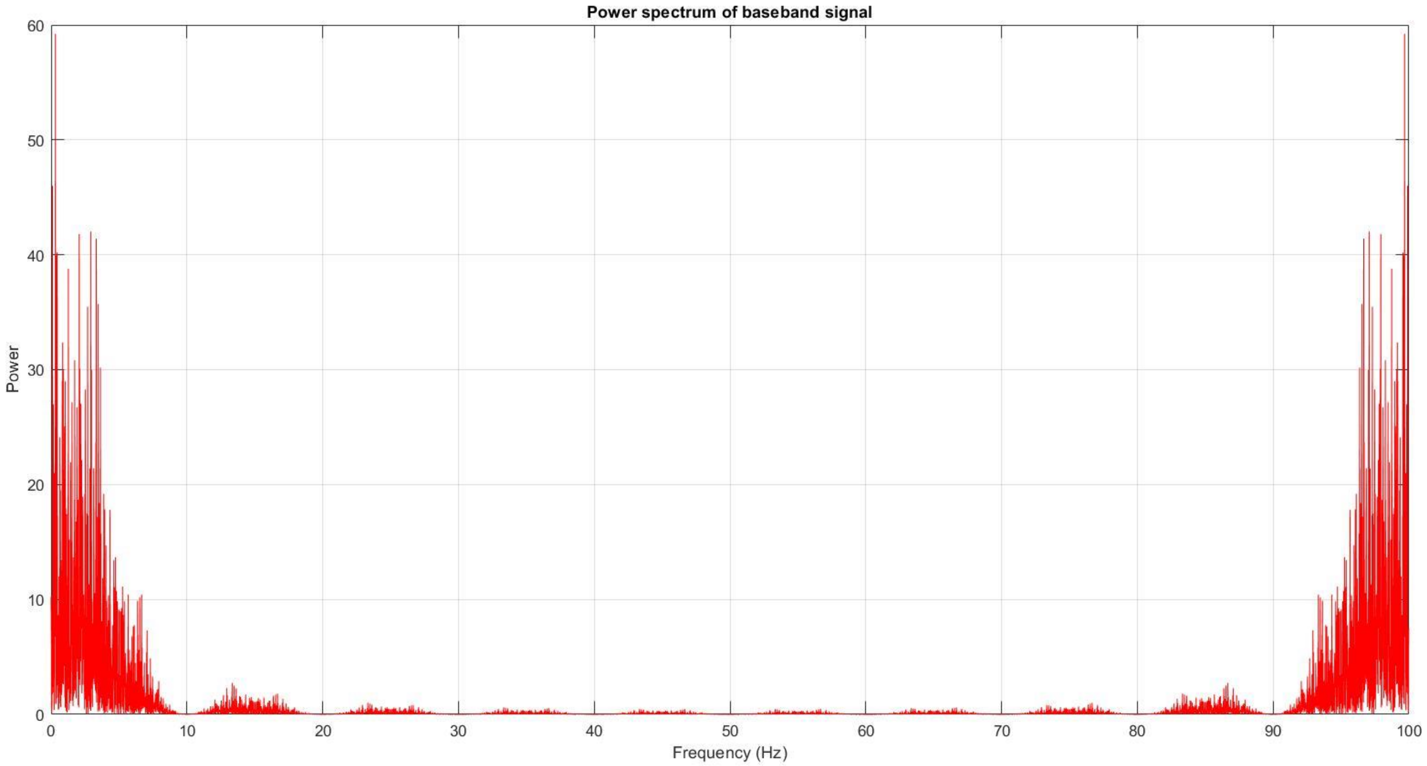
OUTPUT

```
Bits generated:
1  0  1  1  0  1  1  0  0  1
```

The above bit sequence is then converted to a baseband signal. The baseband signal is obtained by converting 0 and 1 into appropriate pulses of duration $T = 0.1$s. For a bit sequence with $N = 10$, obtain a baseband signal with 0 represented using a level of $-1$ and 1 using a level of 1. Note that all continuous time signals have to be represented by their sampled counterparts. Clearly state the sampling rate that you have used. Plot the sampled version of the continuous time signal that you have obtained.



Plot the power spectrum of the baseband signal for $N = 1000$. Note that the power spectrum should be plotted with respect to the continuous time frequency (Hint: carefully think about energy vs. power). Along with this plot that you have obtained, plot (i.e. use *hold on* in Matlab) the PSD that we have obtained from theory in class - compare and contrast the measured spectrum and spectrum obtained from theory.



For modelling a baseband channel use any FIR filter design technique to obtain a filter response that corresponds to a channel with passband edge at 20Hz and a gain of $g$ in the passband. Plot the magnitude spectrum of the channel that you are using - clearly labelling the axes for $g = 1$.

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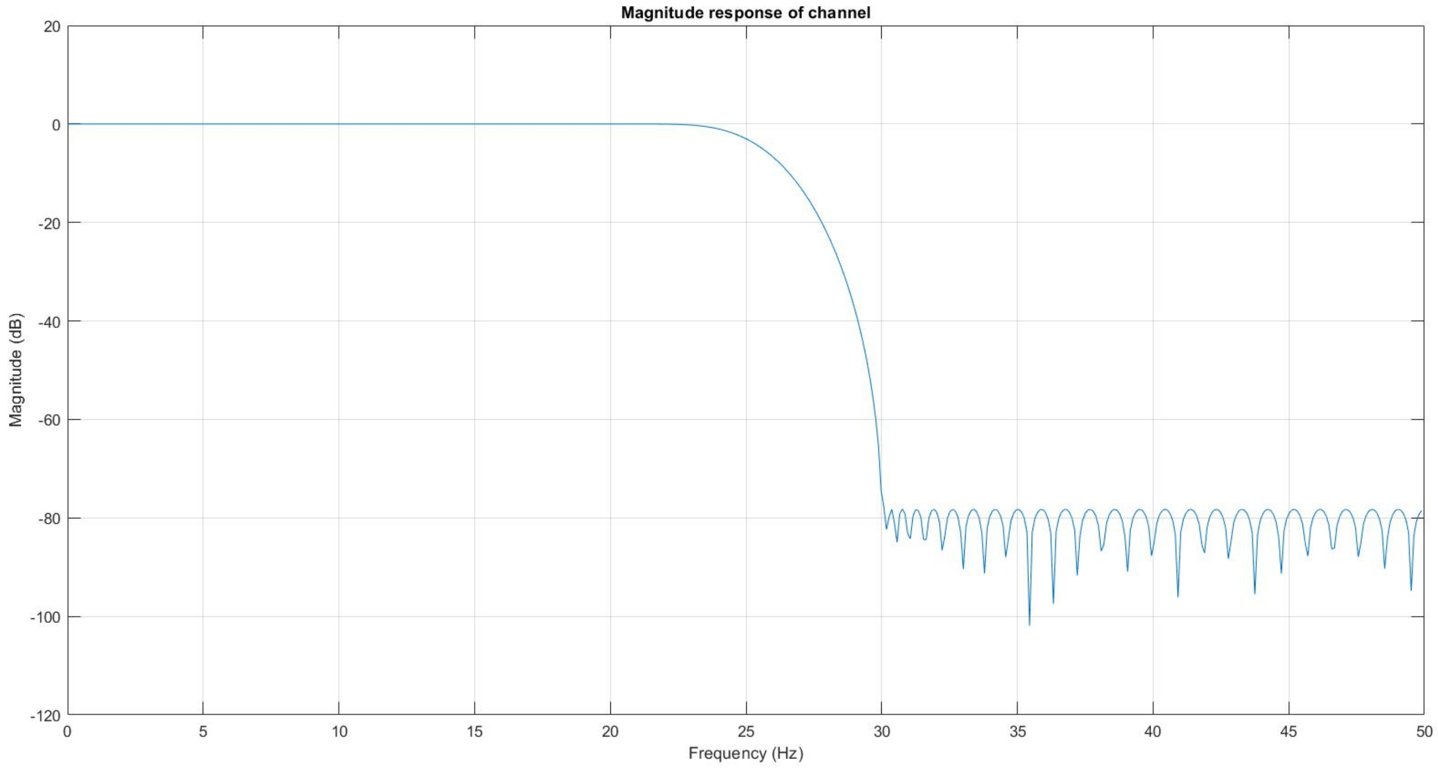
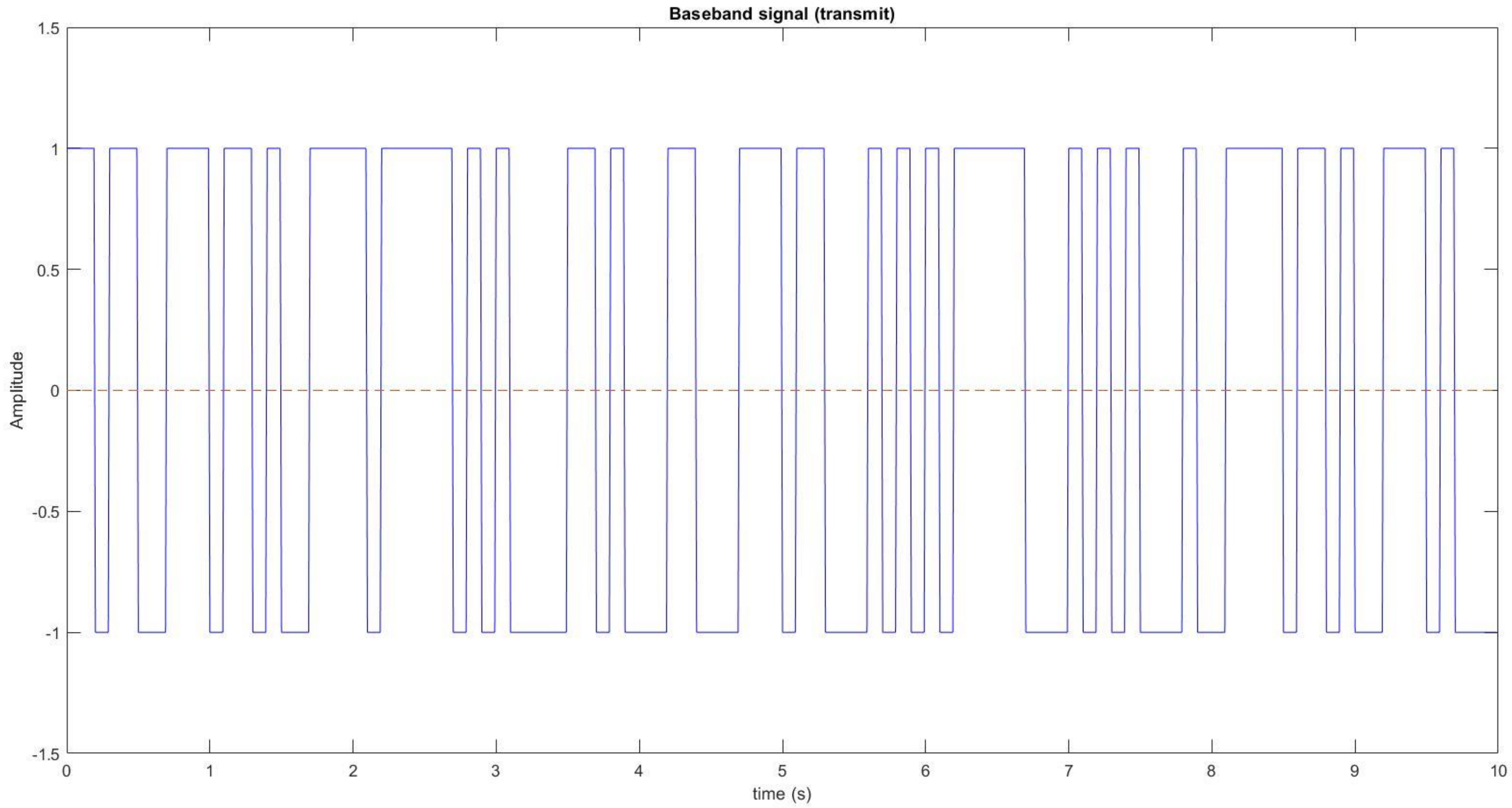


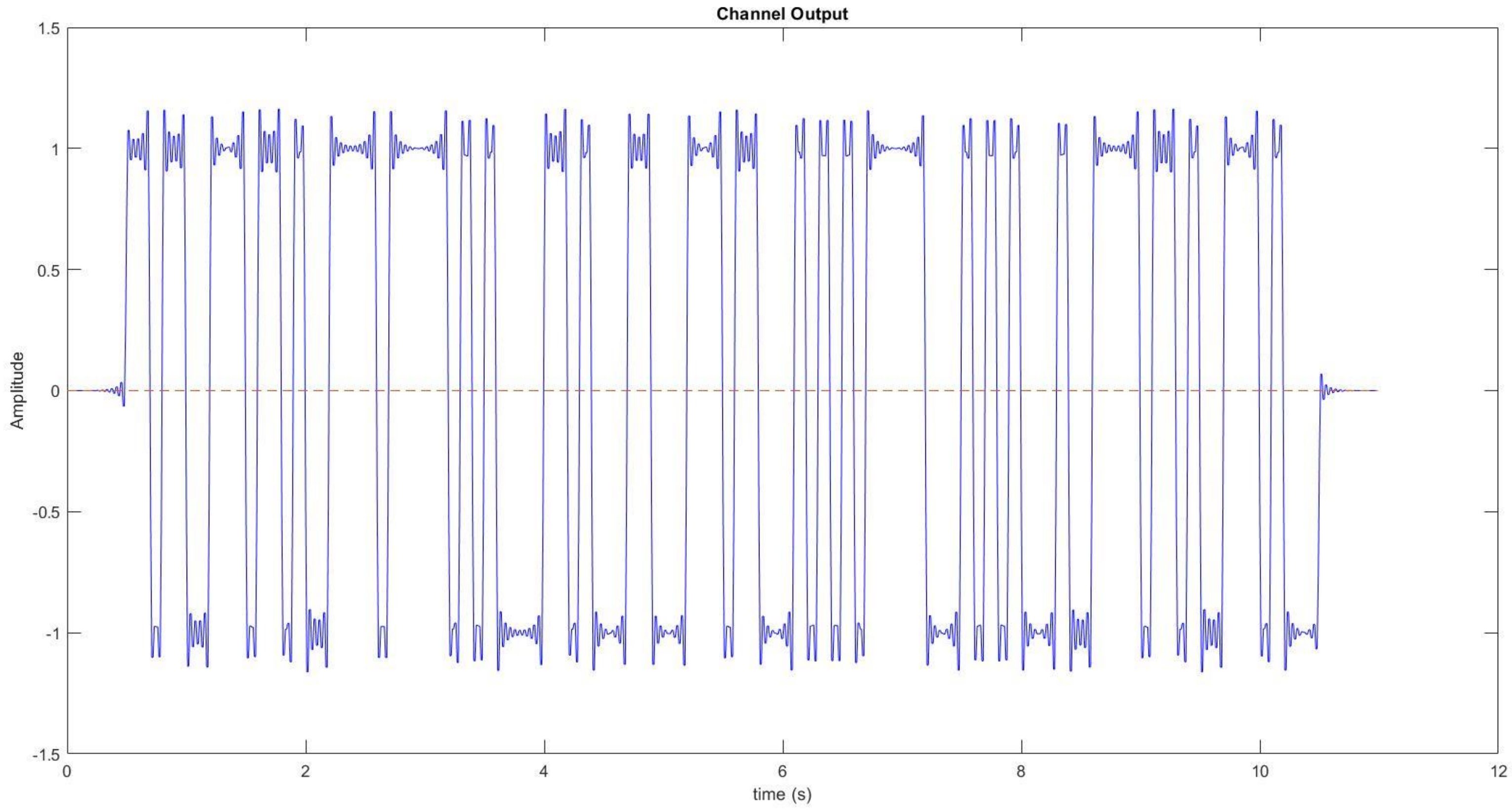
Simulate sending the baseband signal through the above channel. Plot the output signal from the channel.

Signal input to channel



Simulate sending the baseband signal through the above channel. Plot the output signal from the channel.

Signal output from channel



At the output of the channel, implement a low pass receive filter. Plot the magnitude response of the filter that you have implemented. What are the specifications of the passband and stopband for this filter? Why did you choose those specifications?

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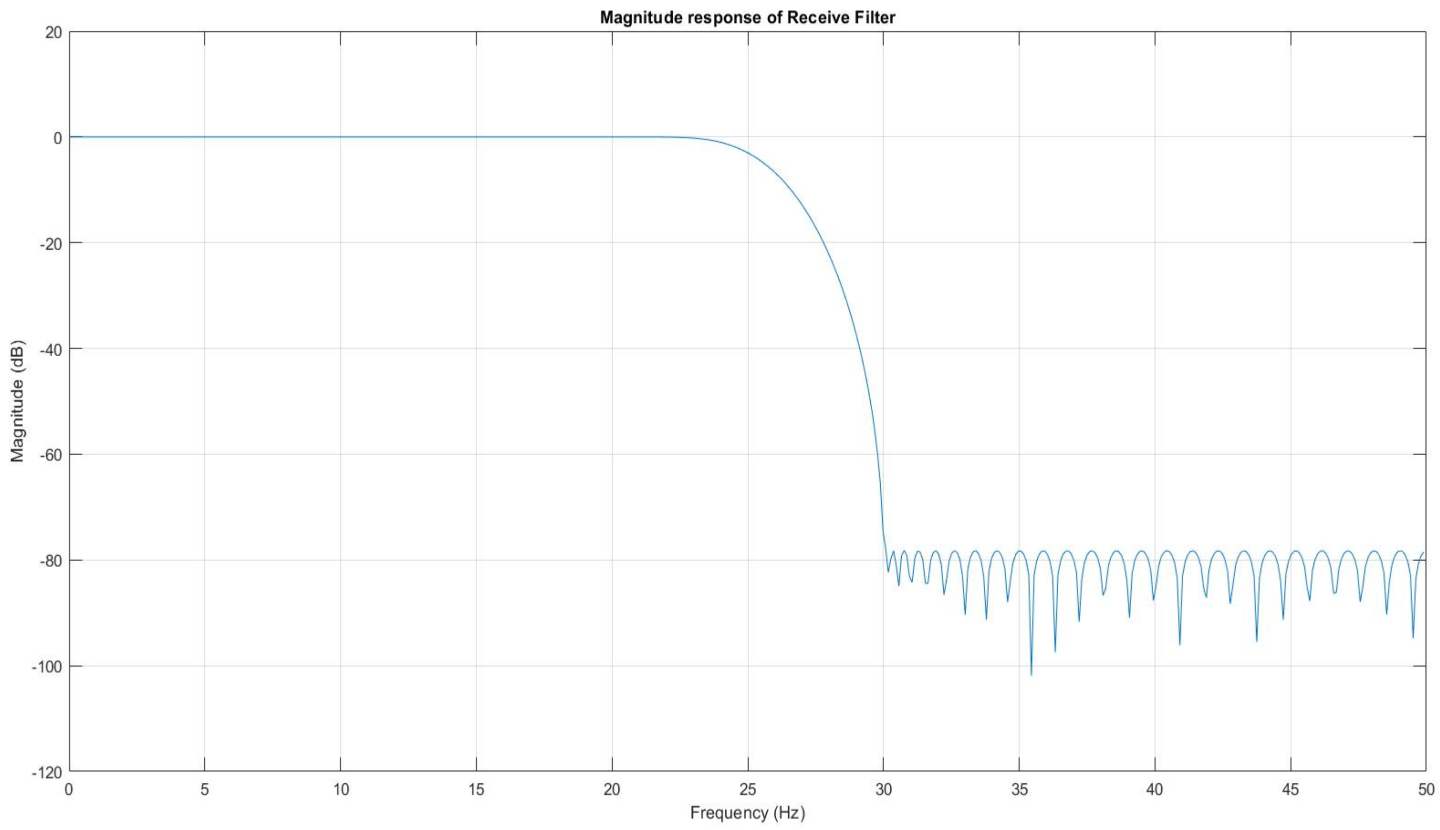
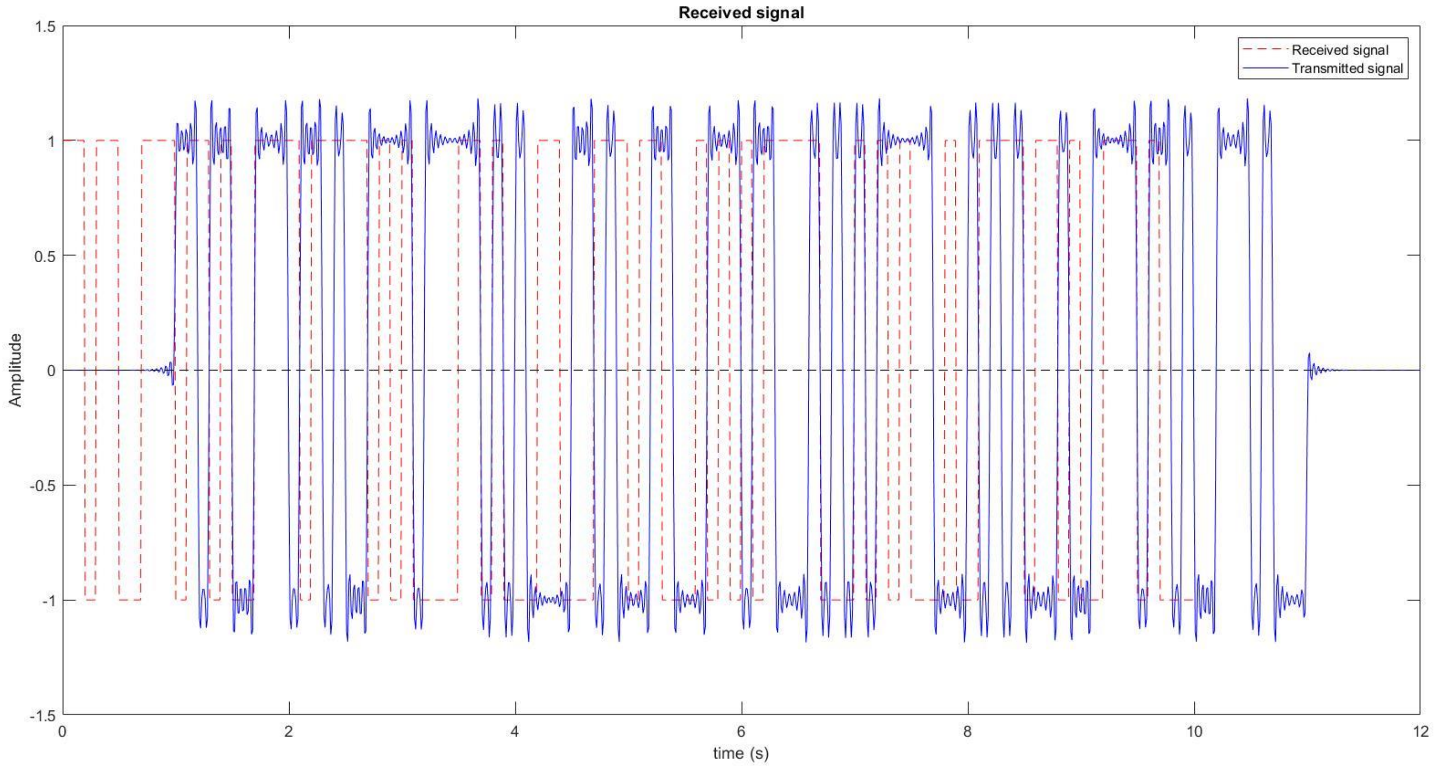
**Filter specifications:**
Passband frequency = 20 Hz
Stopband frequency = 30 Hz
Passband gain = 0 dB
Stopband attenuation ~ 80 dB

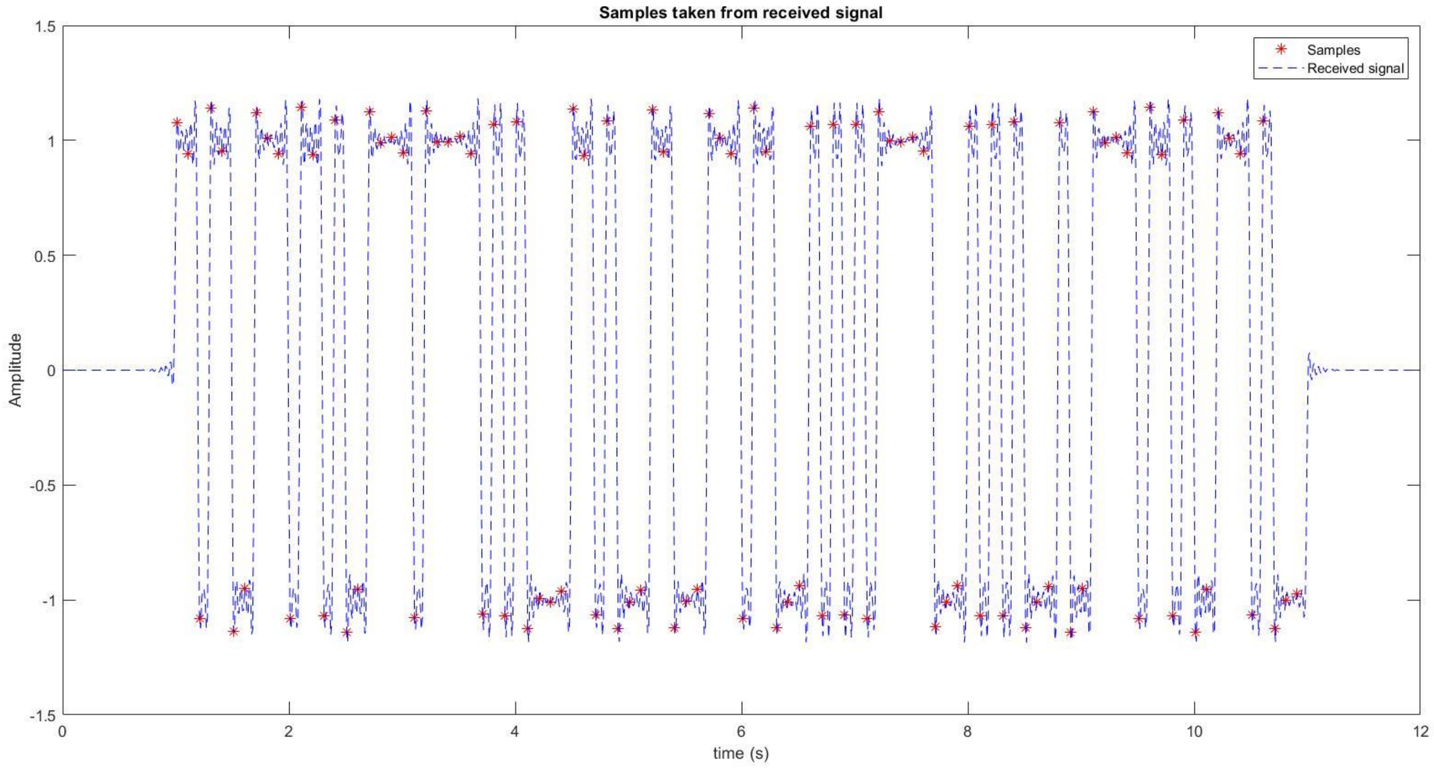
**Reasons for the specification choice:**
Having stopband frequency smaller than the channel cut-off would remove the smaller frequency components of the transmitted signal. Also, keeping passband edge greater than channel cut-off would only invite noise in a practical scenario.



Obtain samples from the output of the filter; in this set of tasks the sampling times can be manually set by inspection of the channel output signal.



Obtain samples from the output of the filter; in this set of tasks the sampling times can be manually set by inspection of the channel output signal.



Implement a decision making device - a thresholder that will convert the samples to 0 or 1, and obtain the bit estimates at the output of the decision device.

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CODE

```
function bits = sample2bits(samples)
bits = zeros(1, length(samples));
bits(samples > 0) = 1;
end
```

```
%% Decision maker - samples to bits
bitsReceived = sample2bits(samples);
bitErrors = length(find((bitsReceived ~= bits)));
```

OUTPUT

Number of error bits = 0

# Result

A digital baseband communication system was simulated in MATLAB assuming perfect frame and symbol synchronization.