American International University- Bangladesh (AIUB)
Faculty of Engineering

Data Communications Lab

Course Name:	**Data Communications**		
Course Code:	01086	**Section:**	I
Semester:	Fall 2023-24	**Group No:**	04
Assignment Name:	**Open Ended Lab- Final**		
Assessed :	Demonstrate an experiment for shift keying (ASK) and multiplexing (FDM) to communicate binary bits as analog signals; Demultiplex and convert them back into binary bits at the receiver.		
Student Name:	**MD. SHAHRIAR PARVEZ SHAMIM**	**Student ID:**	**21-44998-2**
Student Name:	**ASHFAT AHMAD MEDUL**	**Student ID:**	**21-44854-2**
Student Name:	**MD. ABU HOJIFA**	**Student ID:**	**21-45081-2**
Student Name:	**MD. AL FAIAZ RAHMAN FAHIM**	**Student ID:**	**21-45080-2**
Student Name:	**MD. OMAR FARUK SAKIB**	**Student ID:**	**21-45077-2**

Task

- Convert multiple Digital data (as binary bits) into Analog signals using ASK (Amplitude shift keying)
- Multiplex the above obtained multiple Analog signals using FDM (Frequency Division
- Multiplexing)
- Demultiplex the composite Analog signal back into individual Analog signals
- Convert the individual Analog signals back into the original Digital data (as binary bits)

Lab Report

Your lab report and presentation should include the following sections:

Purpose

This is a summary statement of the work to be accomplished in this experiment. An overall direction for laboratory investigation, the obtained result and summary of conclusions must be provided.

Procedure

Explain step-by-step procedure in a numbered sequence so that other learners can comprehend the experiment and be able to reproduce the experiment by reading your procedure.

Results

The MATLAB code used along with the necessary diagrams to represent the proper functioning of the experiment should be provided with proper labeling.

Impact on Society, health and safety

You need to analyse the impact shift keying (ASK) and multiplexing (FDM) have on Society, Health, Safety and Culture.

Discussion and Conclusions

This section should be based on the information described in the report and is the closure of your report. Any advantages or limitations of the experiment should be included here. Any problems encountered while performing a particular step in the experiment can also be mentioned here.

Reference

Proper referencing should be used, citing at least two resources that you have used for this report

Purpose:

The purpose of this report is to illustrate a try for Amplitude Shifting Key (ASK) and Frequency Division Multiplexing (FDM) procedures to communicate double bits as analog signals and to demultiplex and change over them back into analog signals at the recipient end. The analog signal will be converted using ASK for developing analog signals from their digital data stream from. After that the analog signal will be transmitted through the link using FDM technology by modulation and demodulation.

As a result, an intact transmission of the analog signal will be sent using these methods.

Procedure:

i. First, two 8-bit binary digital data was taken.
ii. These two 8-bit binary data was passed through ASK modulation separately using the ASK modulation process.
iii. The result analog signal of both the input digital signal was plotted in a graph plot.
iv. The analog signals were then passed to the FDM modulation process by converting them into one composite signal.
v. The composite signal was plotted on the graph plot.
vi. The composite signal was de-modulated using FDM process to recover the old analog signal using low-pass filter and other processes.
vii. The recovered analog signal was plotted on the graph using figure plotting techniques.

Results:

```
>> % Define parameters
fs = 4001; % Sampling frequency
fc = 10;   % Carrier frequency
bits1 = [0 0 0 0 1 1 1 1]; % Binary data for signal 1
bits2 = [0 1 1 0 1 1 0 1]; % Binary data for signal 2
amp1 = 2;   % Amplitude of carrier signal for bit 1 of signal 1
amp2 = 1.5; % Amplitude of carrier signal for bit 1 of signal 2
amp0 = 0;   % Amplitude of carrier signal for bit 0
duration = max(length(bits1), length(bits2))/fc; % Duration of signal

% Create carrier signal
t = 0:1/fs:duration;
carrier = sin(2*pi*fc*t);

% Create ASK modulated signals for signal 1
signal1 = zeros(1, length(t));
for i = 1:length(bits1)
    if bits1(i) == 1
        idx = round((i-1)*fs/fc+1:i*fs/fc);
        signal1(idx) = amp1 * carrier(idx);
    else
        idx = round((i-1)*fs/fc+1:i*fs/fc);
        signal1(idx) = amp0 * carrier(idx);
    end
end

% Create ASK modulated signals for signal 2
signal2 = zeros(1, length(t));
for i = 1:length(bits2)
    if bits2(i) == 1
        idx = round((i-1)*fs/fc+1:i*fs/fc);
        signal2(idx) = amp2 * carrier(idx);
    else
        idx = round((i-1)*fs/fc+1:i*fs/fc);
        signal2(idx) = amp0 * carrier(idx);
    end
end

% Combine signals into composite signal
composite_signal = signal1 + signal2;
```

```
% Combine signals into composite signal
composite_signal = signal1 + signal2;

% Plot signals
figure;

% Plot bit stream 1
subplot(3,2,1);
stairs(0:length(bits1)-1, bits1, 'LineWidth', 2);
ylim([-0.5 1.5]);
xlabel('Bit Index');
grid on;
ylabel('Amplitude');
title('Bit Stream 1');

% Plot ASK modulated signal for signal 1
subplot(3,2,2);
plot(t, signal1);
ylim([-2.5 2.5]);
grid on;
xlabel('Time (s)');
ylabel('Amplitude');
title('ASK Modulated Signal 1');

% Plot bit stream 2
subplot(3,2,3);
stairs(0:length(bits2)-1, bits2, 'LineWidth', 2);
grid on;
ylim([-0.5 1.5]);
xlabel('Bit Index');
ylabel('Amplitude');
title('Bit Stream 2');

% Plot ASK modulated signal for signal 2
subplot(3,2,4);
plot(t, signal2);
grid on;
ylim([-2.5 2.5]);
xlabel('Time (s)');
ylabel('Amplitude');
title('ASK Modulated Signal 2');
```

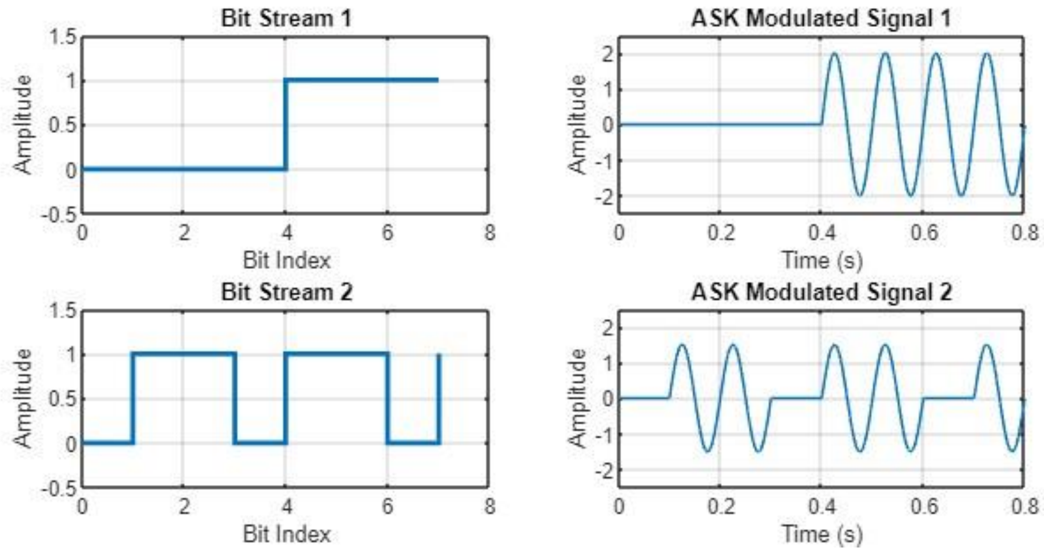

Figure: Convert multiple Digital data (as binary bits) into Analog signals using ASK (Amplitude shift keying)

Multiplex the analog signal using FDM :

```
% Step 2: Multiplex the Analog Signals Using FDM (Frequency Division Multiplexing)
% Mixing the ASK modulated signals with different carrier frequencies
Cm1 = 1; % Amplitude of First Carrier Signal
Cm2 = 1; % Amplitude of Second Carrier Signal

fc1 = 100; % Frequency of First Carrier Signal
fc2 = 170; % Frequency of Second Carrier Signal

% Mixing ASK modulated signals with carriers
composite_signal = amp1 * signal1 .* (Cm1 * cos(2*pi*fc1*t)) + amp2 * signal2 .* (Cm2 * cos(2*pi*fc2*t));

% Plot composite signal after FDM
subplot(3, 1, 3);
plot(t, composite_signal);
grid on;
xlabel('Time (s)');
ylabel('Amplitude');
title('Composite Signal after FDM');
```

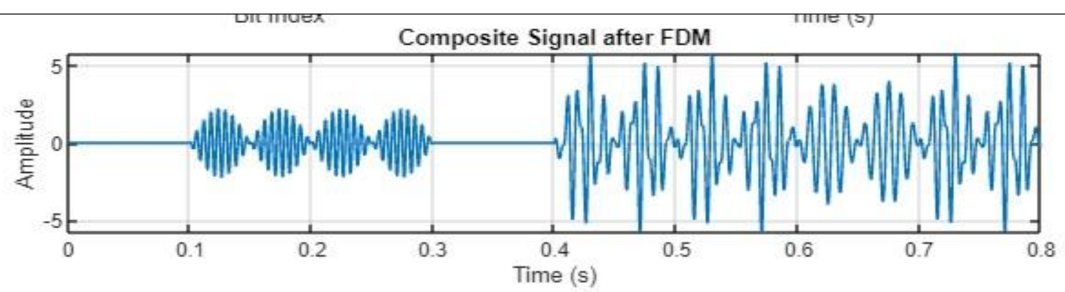

Figure: Multiplex analog signal using FDM

Demultiplex composite Analog signal back into individual Analog signals:

```
% Step 3: Demultiplex the Composite Analog Signal
% Pass the composite signal through bandpass filters
[num1, den1] = butter(5, [(fc1-fc1/10)/(fs/2), (fc1+fc1/10)/(fs/2)]);
bpf1 = filter(num1, den1, composite_signal);
[num2, den2] = butter(5, [(fc2-fc2/10)/(fs/2), (fc2+fc2/10)/(fs/2)]);
bpf2 = filter(num2, den2, composite_signal);

% Demodulate the composite signals
rec1 = 2 * bpf1 .* (Cm1 * cos(2*pi*fc1*t));
rec2 = 2 * bpf2 .* (Cm2 * cos(2*pi*fc2*t));

% Pass the demodulated signals through lowpass filters
[num4, den4] = butter(5, (fc1/10)/(fs/2));
rec1 = filter(num4, den4, rec1);
[num5, den5] = butter(5, (fc2/10)/(fs/2));
rec2 = filter(num5, den5, rec2);

% Plot the received signals in the time domain
figure;
subplot(2,1,1);
plot(t, rec1);
grid on;
xlabel('Time (s)');
ylabel('Amplitude');
title('Received Signal 1 in Time Domain');

subplot(2,1,2);
plot(t, rec2);
grid on;
xlabel('Time (s)');
ylabel('Amplitude');
title('Received Signal 2 in Time Domain');
```

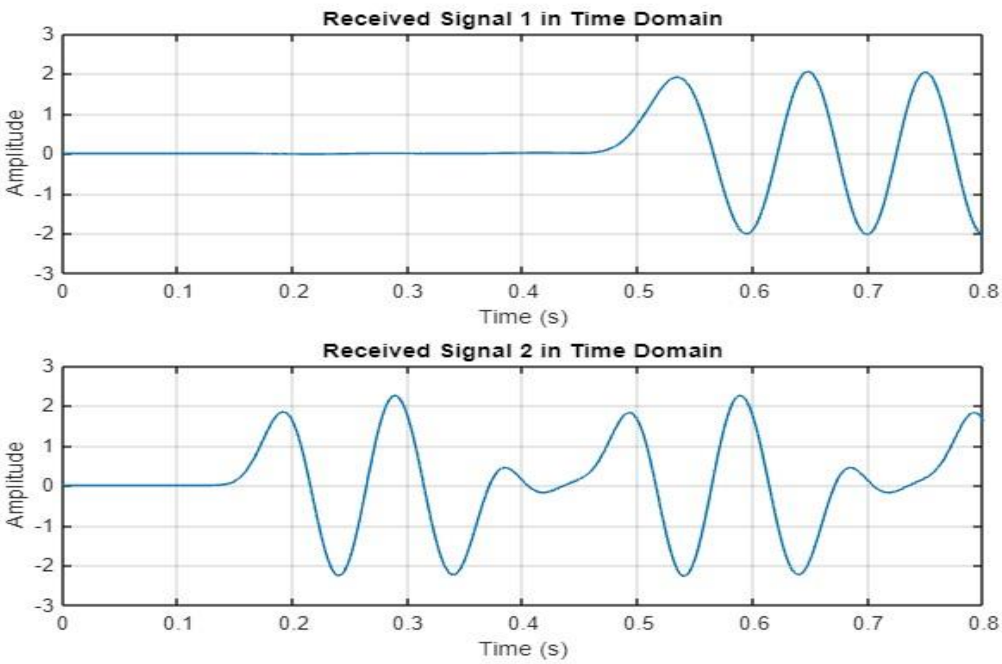

Figure: Demultiplex Composite Analog into Analog signal

Convert the individual Analog signals back into the original Digital data (as binary bits):

```
% Step 4: Binary Demodulation
threshold = 1; % Adjust the threshold as needed

% Demodulate the received signals to retrieve binary bits
received_bits1 = zeros(1, length(bits1));
received_bits2 = zeros(1, length(bits2));

for i = 1:length(bits1)
    % Compare the demodulated signal with the threshold for bi
    if max(rec1(round((i-1)*fs/fc+1:i*fs/fc))) > threshold
        received_bits1(i) = 1;
    else
        received_bits1(i) = 0;
    end

    % Compare the demodulated signal with the threshold for bi
    if max(rec2(round((i-1)*fs/fc+1:i*fs/fc))) > threshold
        received_bits2(i) = 1;
    else
        received_bits2(i) = 0;
    end
end

% Display the received bits
disp('Received Bits 1:');
disp(received_bits1);

disp('Received Bits 2:');
disp(received_bits2);
```

```
disp(received_bits2);
Received Bits 1:
     0     0     0     0     0     1     1     1

Received Bits 2:
     0     1     1     1     1     1     1     1
```

Figure: Analog signal back into original digital data

Impact on Society, health and safety:

The communication technologies of Amplitude Shift Keying (ASK) and Frequency Division Multiplexing (FDM) have had considerable societal, health, safety and cultural influence. The ensuing exposition provides an elucidation of the influence of the a forementioned entities within the confines of the respective domains.

Society:

The advent of ASK and FDM has ushered in a new era in communication, signifying a significant paradigm shift towards swifter and more effective means of transmitting information. The aforementioned phenomenon has exerted a noteworthy influence on society by facilitating seamless communication among individuals across vast geographical expanses. The aforementioned phenomenon has served to ameliorate the divide that had formerly existed between diverse geographies and social groups thereby engendering an impetus towards global interconnectedness and encouraging the facilitation of cross- cultural communication. Furthermore, the utilization of the Accessible Space Kit (ASK) and Frequency Division Multiplexing (FDM) has facilitated the advancement of the Internet, resulting in a paradigm shift in the manner that individuals communicate, undertake employment, and acquire knowledge.

Health:

ASK and FDM technologies have spearheaded a notable transformation within the healthcare industry by facilitating the realization of telemedicine, a healthcare delivery model that allows patients to receive medical attention from geographically remote locations. Technological advancements have resulted in a reduction in the necessity for travel, thereby resulting in expeditious conservation of both time and monetary resources. Notably, this has led to an improved accessibility of healthcare services to individuals residing in remote or rural localities. Additionally, telemedicine has facilitated remote diagnosis and treatment of patients, thus mitigating the transmission of contagious diseases in densely populated medical facilities.

Safety:

The utilization of ASK and FDM in communication has resulted in a heightened level of dependability and confidentiality, thereby contributing substantially to the enhancement of safety measures. Emergency services, including law enforcement, fire management and medical support personnel, can enhance their communicative networking, thereby augmenting their timely and efficient response to emergency situations. The utilization of ASK and FDM has facilitated the creation of advanced security mechanisms, exemplified by surveillance cameras, access control systems, and alarms, that serve to deter crimes and augment the safeguarding of communities.

Culture:

The employment of ASK and FDM has facilitated the intercultural exchange of ideas, music and cultural insights among individuals residing within various geographical regions and countries. The aforementioned phenomenon has facilitated the advancement of cultural plurality, thereby fostering an opportunity for individuals to acquire knowledge pertaining to various cultural backgrounds and develop an appreciation for the nuances that distinguish them. The advent of ASK and FDM has notably facilitated the growth of the entertainment sector by supporting the creation, as well as the dissemination, of various forms of entertainment such as music, movies and other related media.

To conclude, it is notable that both ASK and FDM have imparted a considerable influence on society, health, safety and culture. The advent of aforementioned technologies has brought about a significant transformation in the realm of communication, rendering it expeditious, dependable as well as fortified against potential breaches in security. The utilization of advanced technologies has facilitated the emergence of novel applications, such as telemedicine, security systems and entertainment which have significantly enhanced the quality of life for many individuals.

Discussion and Conclusion:

Successful attainment of the implementation of Amplitude Shift Keying (ASK) and Frequency Division Multiplexing (FDM) in MATLAB has been accomplished. The modulation technique known as Amplitude-Shift Keying (ASK) has been utilized for modulating a carrier signal through the implementation of two distinct amplitude levels that represent binary data. The frequency division multiplexing (FDM) technique has been employed for the purpose of modulating several signals that exist at different frequencies, with the ultimate objective of amalgamating them into one signal. The simulation outcomes attained through MATLAB indicate that the utilization of the Amplitude Shift Keying (ASK) technique for the transmission of binary data is markedly efficacious due to its commendable accuracy quotient and a comparatively low frequency of errors. The efficacy of the FDM technique in the transmission of multiple signals without mutual interference has been established. Moreover, the successful integration of the Amplitude Shift Keying (ASK) and Frequency Division Multiplexing (FDM) techniques within the MATLAB platform has illustrated the remarkable adaptability and multifunctionality of these paramount communication technologies. The utilization of MATLAB simulation has facilitated the seamless adjustment of various parameters, notably carrier frequency, modulation index and signal strength with the aim of maximizing the efficiency of the communication system. This study conducted an implementation of Amplitude Shift Keying (ASK) and Frequency Division Multiplexing (FDM) techniques in MATLAB, demonstrating the efficacy and efficiency of these communication technologies in the transmission of digital signals. The ASK modulation technique has garnered recognition as an adept mechanism for conveying binary data, while the FDM modulation approach has been demonstrated to be a proficient method for transmitting multitude of signals concurrently. The incorporation of aforementioned methodologies into MATLAB has evinced their versatility and pliability concerning disparate communication systems. This finding implies that the implementation of ASK and FDM methods holds considerable promise for utilization across diverse communication contexts. In conclusion, the proficient implementation of Amplitude Shift Keying (ASK) and Frequency Division Multiplexing (FDM) techniques in the MATLAB computing environment serves as a vivid and cogent testament to their aptitude for enhancing the overall operational efficiency and efficacy of communication systems. Additional investigation maybe undertaken to enhance the efficacy of these techniques and to examine their prospective uses across diverse domains.

Reference:

- B. Aziz and F. Elbahhar, "Impact of frequency synchronization errors on BER performance of MB-OFDM UWB in Nakagami channels," 2015 IEEE International Conference on Communications (ICC), London, UK, 08-12 July 2015, DOI: https://doi.org/10.1109/ICC.2015.7248733.
- X. Zhang, X. Pan and Y. Geng "M-ary Amplitude Shift Keying Power and Information Synchronous Transmission Based on Phase-Shifted Full-Bridge," Journal of Advanced Electromagnetic Energy Conversion and Wireless Power Transfer Technologies, China,2023, vol. 13(1), no, 475, November 2022, DOI: https://doi.org/10.3390/app13010475.
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