EXPERIMENT – 6

Binary-ASK And M-ary ASK

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Aim:

To implement Binary Amplitude Shift Keying (BASK) and M-ary ASK (M = 4, 8) for a given binary message sequence. Verify the decoded bits at the receiving end and plot the corresponding waveforms.

Theory:

Amplitude Shift Keying (ASK)

is a digital modulation technique where the amplitude of a carrier signal varies according to the digital data. The frequency and phase of the carrier remain constant while the amplitude changes to represent binary data.

1. **Binary ASK (BASK):**
   - Also known as On-Off Keying (OOK), BASK uses two distinct amplitude levels to represent binary '1' and '0'.
   - The modulated BASK signal is given by: $s(t) = b(t).A_c \cos(2\pi f_c t)$
     where is the carrier amplitude, is the carrier frequency, and is the binary data signal.
2. **M-ary ASK:**
   - Extends BASK by allowing M different amplitude levels, where $M = 2^k$ and k is the number of bits per symbol.
   - The modulated M-ASK signal is expressed as: $s(t) = A_m \cos(2\pi f_c t)$
     where takes one of M discrete amplitude values.
   - Example:
     4-ASK: Uses 4 amplitude levels to represent 2 bits per symbol.
     8-ASK: Uses 8 amplitude levels to represent 3 bits per symbol.

Advantages of M-ASK:

Higher data rates as multiple bits are transmitted per symbol.

Improved bandwidth efficiency compared to BASK.

Disadvantages of M-ASK:

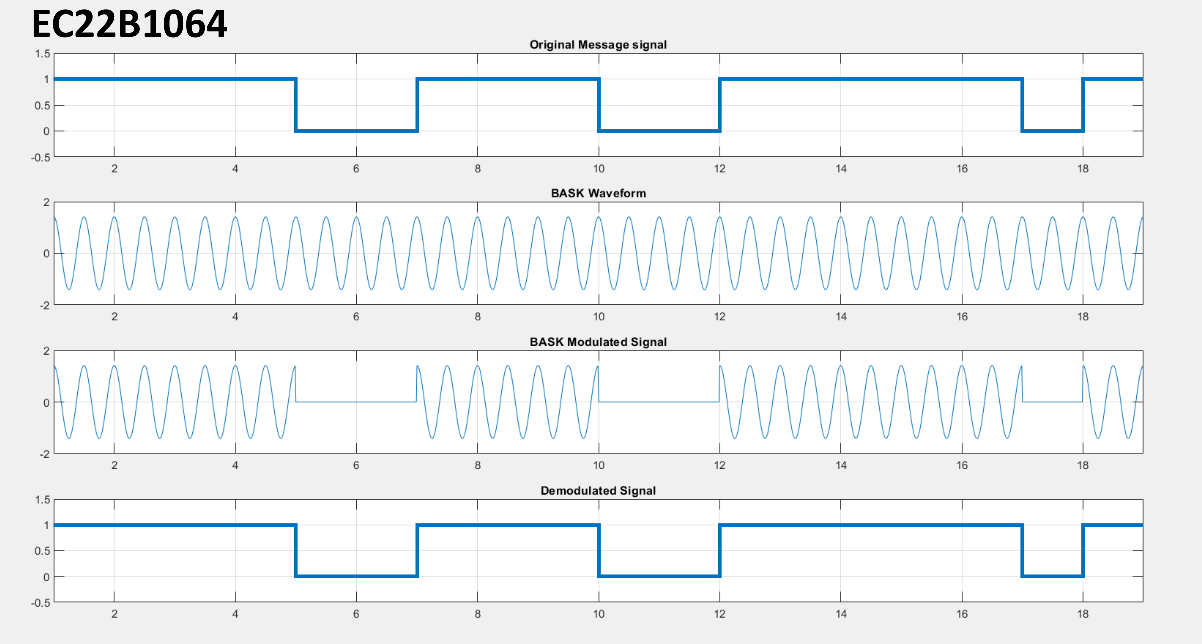
Increased complexity in modulation and demodulation.

Higher noise susceptibility as M increases, leading to greater chances of symbol errors.

Q1)Perform Binary Amplitude Shift Keying (BFSK) and decode the signal.

```
fs=100;
fc = 2;
y = zeros(1,20);
Tb = 1;
Eb = 1;
N = length(y);
t = 0:1/fs:N*Tb-(1/fs);
y(1:5) = 1;
y(8:10) = 1;
y(13:17) = 1;
y(19:20) = 1;
subplot(4,1,1)
stairs(0:N-1,y,LineWidth=3);
ylim([-0.5, 1.5]);
xlim([1,19]);
grid on;
title("Original Message signal");
c = sqrt(2*Eb/Tb).*cos(2*pi*fc*t);
subplot(4,1,2)
plot(t,c);

title("BASK Waveform");
xlim([1,19]);
grid on;
s = zeros(1,length(t));
for i = 1:N
    if y(i) == 1
        s((i-1)*fs*Tb+1:i*fs*Tb) = sqrt(2*Eb/Tb) * cos(2*pi*fc*t((i-1)*fs*Tb+1:i*fs*Tb));
    end
end
subplot(4,1,3)
plot(t,s);
title("BASK Modulated Signal");
xlim([1,19]);
grid on;

N1 = length(s);
dem = zeros(1, N);

for i = 1:N
    % Extract signal segment corresponding to the i-th bit
    segment = s((i-1)*fs*Tb+1:i*fs*Tb);

    % Compute the envelope (absolute value)
    avg_amplitude = mean(abs(segment));


    if avg_amplitude >= 0.5
        dem(i) = 1;
    else
        dem(i) = 0;
    end
end

subplot(4,1,4)
stairs(0:N-1, dem, Linewidth=3);
```

```
ylim([-0.5, 1.5]);
xlim([1,19]);
grid on;
title("Demodulated Signal");
```



Q2) Perform M-ary Amplitude Shift Keying (M=4, M=8) and decode the signal.

```
fs = 1000;
Tb = 1;
fc = 5;
t = 0:1/fs:Tb-1/fs;
symbols_4 = [0 1 2 3];
symbols_8 = [0 1 2 3 4 5 6 7];

message_4 = randi([0 3], 1, 10);
message_8 = randi([0 7], 1, 10);

carrier = cos(2*pi*fc*t);

modulated_4 = [];
for i = 1:length(message_4)
    modulated_4 = [modulated_4, symbols_4(message_4(i)+1) * carrier];
end

modulated_8 = [];
for i = 1:length(message_8)
    modulated_8 = [modulated_8, symbols_8(message_8(i)+1) * carrier];
end

demodulated_wave_4 = modulated_4 .* repmat(carrier, 1, length(message_4));
```

```
demodulated_wave_8 = modulated_8 .* repmat(carrier, 1, length(message_8));

demodulated_4 = [];
for i = 1:length(message_4)
    received = demodulated_wave_4((i-1)*length(t) + 1 : i*length(t));
    demodulated_4 = [demodulated_4, trapz(t, received)];
end

demodulated_8 = [];
for i = 1:length(message_8)
    received = demodulated_wave_8((i-1)*length(t) + 1 : i*length(t));
    demodulated_8 = [demodulated_8, trapz(t, received)];
end

decoded_4 = round((demodulated_4 - min(demodulated_4)) / (max(demodulated_4) / 3));
decoded_8 = round((demodulated_8 - min(demodulated_8)) / (max(demodulated_8) / 7));

figure;
subplot(4,1,1);
stairs([message_4 message_4(end)], 'LineWidth', 1.5);
ylim([-0.5 3.5]);
title('Message Symbols (M=4)');

grid on;

subplot(4,1,2);
plot(modulated_4, 'LineWidth', 1.5);
title('Modulated Signal (M=4 ASK)');
grid on;

subplot(4,1,3);
plot(demodulated_wave_4, 'LineWidth', 1.5);
title('Demodulated Waveform (M=4 ASK)');
grid on;

subplot(4,1,4);
stairs([decoded_4 decoded_4(end)], 'LineWidth', 1.5);
ylim([-0.5 3.5]);
title('Decoded Symbols (M=4)');
grid on;

figure;
subplot(4,1,1);
stairs([message_8 message_8(end)], 'LineWidth', 1.5);
ylim([-0.5 7.5]);
title('Message Symbols (M=8)');

grid on;

subplot(4,1,2);
plot(modulated_8, 'LineWidth', 1.5);
title('Modulated Signal (M=8 ASK)');
grid on;

subplot(4,1,3);
plot(demodulated_wave_8, 'LineWidth', 1.5);
title('Demodulated Waveform (M=8 ASK)');
grid on;
```

```
subplot(4,1,4);
stairs([decoded_8 decoded_8(end)], 'LineWidth', 1.5);
ylim([-0.5 7.5]);
title('Decoded Symbols (M=8)');
grid on;
```

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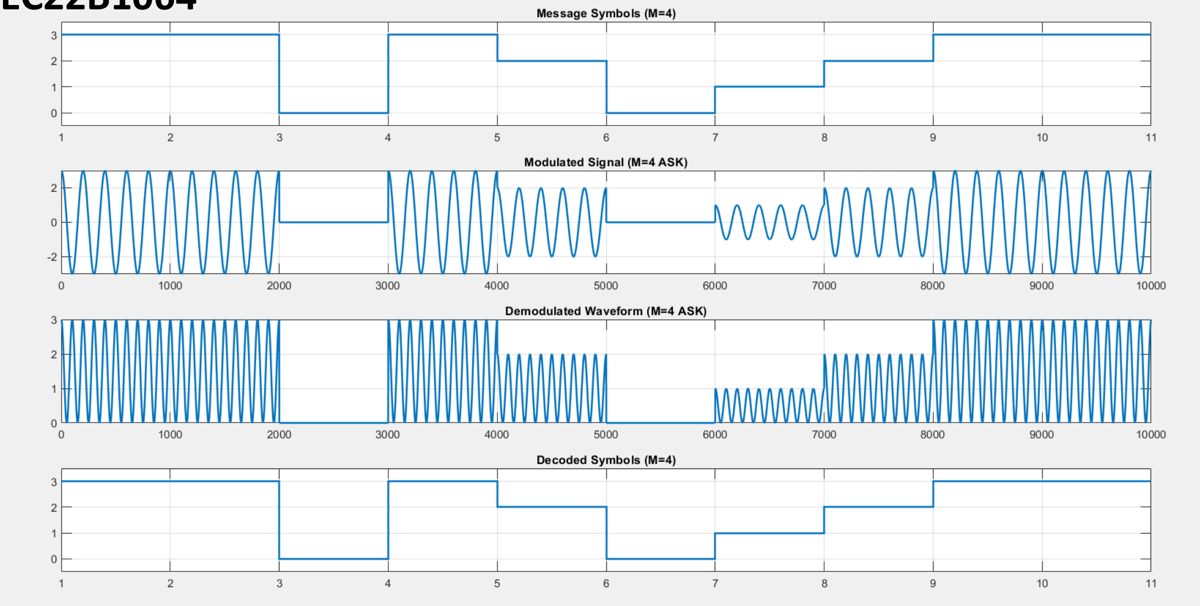

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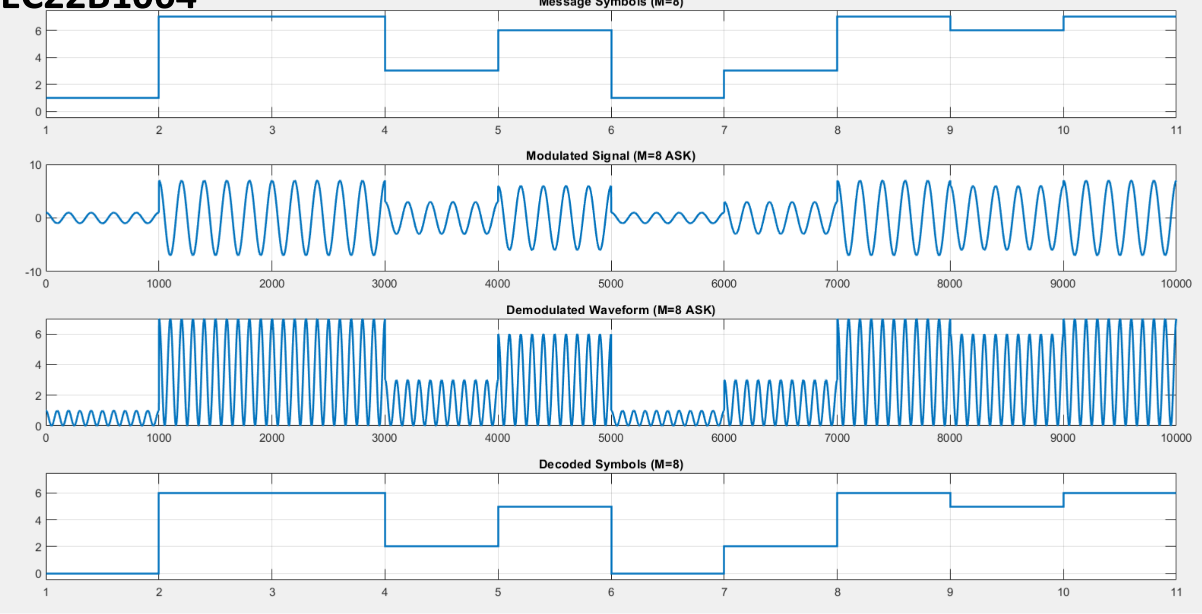

Inference:

- In BASK, the carrier is switched on and off, making it simple but prone to noise.
- In M-ASK, multiple amplitude levels allow transmission of more data per symbol, increasing efficiency but requiring better signal processing.
- As M increases, the system becomes more complex and susceptible to noise

Conclusion:

- ASK is an efficient modulation technique for digital communication, widely used in optical fiber and wireless communication.
- M-ASK improves data transmission rates but requires better signal-to-noise ratio and more complex demodulation techniques.
- The experiment successfully demonstrates BASK and M-ASK, verifying the transmitted and received signals.

References:

[1] Simon Haykins, Communication systems, 2nd ed. (New York John Wiley and Sons, 2005).