AIM

To Simulate M-PSK and M-QAM Modulation Techniques with the help of MATLAB software where M= 4, 8, 16, 32, 64. Also plot the constellation diagram for each M.

THEORY

Phase Shift Keying

Phase Shift Keying (PSK) is the digital modulation technique in which the phase of the carrier signal is changed by varying the sine and cosine inputs at a particular time. PSK technique is widely used for wireless LANs, bio-metric, contactless operations, along with RFID and Bluetooth communications.

Binary Phase Shift Keying (BPSK)

This is also called as **2-phase PSK** (or) **Phase Reversal Keying**. In this technique, the sine wave carrier takes two phase reversals such as 0° and 180°.

BPSK is basically a DSB-SC (Double Sideband Suppressed Carrier) modulation scheme, for message being the digital information.

Quadrature Phase Shift Keying (QPSK)

ASK, FSK and BPSK transmit one bit per symbol and hence carrier is assumed to have one of the two possible states to transmit 1 or 0.

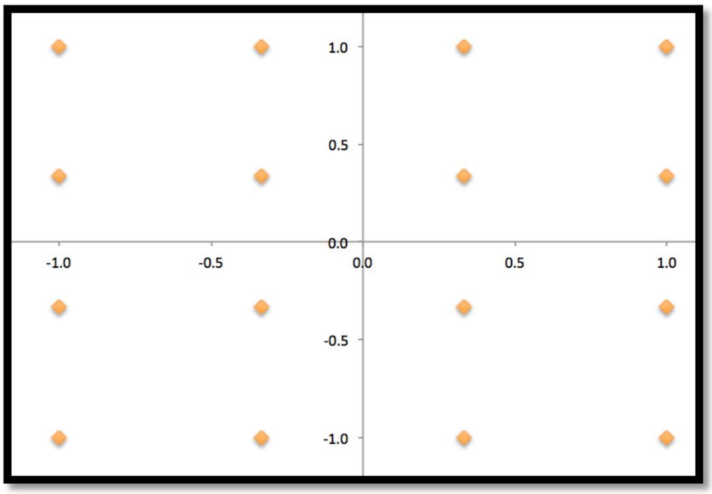
Quadrature Phase Shift Keying (QPSK) is a form of Phase Shift Keying which transmits two bits per symbol.

Since it transmits two bits per symbol there are four possible combinations and thus there is four different phases.

- For /4 QPSK, the four different phases are 45, 135, 225, 315.
- QPSK symbols are not represented by 0 or 1 but it is represented as 00, 01, 10 and 11.
- QPSK carry twice as much information as ordinary PSK using the same bandwidth.
- QPSK is used for satellite transmission of MPEG2 video, cable modems, videoconferencing, cellular phone systems, and other forms of digital communication over an RF carrier.

Quadrature Amplitude Modulation (QAM)

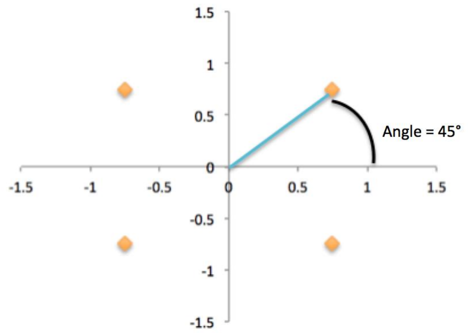
Quadrature Amplitude Modulation, QAM is a form of modulation that is a combination of phase modulation and amplitude modulation. The QAM scheme represents bits as points in a quadrant grid know as a constellation map. Constellation Map



Constellation map of 16-QAM

Phase Modulation

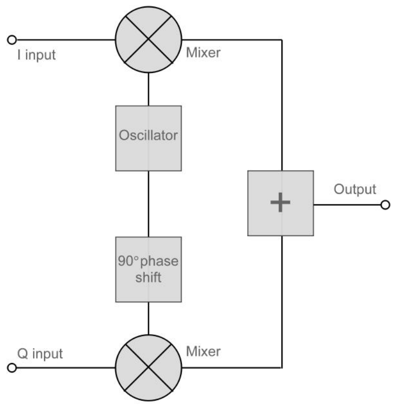
- Represents bits by changing the angle of a wave.
- An example of Phase Modulation is QPSK-4.



- As seen above, QPSK can have four different phase changes as four different angles.
- Is the angle of the constellation point.

QAM modulator

The QAM modulator essentially follows the idea that can be seen from the basic QAM theory where there are two carrier signals with a phase shift of 90° between them. These are then amplitude modulated with the two data streams known as the I or In-phase and the Q or quadrature data streams. These are generated in the baseband processing area.

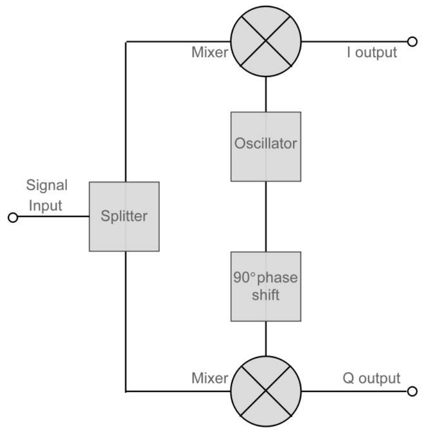


The two resultant signals are summed and then processed as required in the RF signal chain, typically converting them in frequency to the required final frequency and amplifying them as required.

QAM demodulator

The QAM demodulator is very much the reverse of the QAM modulator.

The signals enter the system, they are split and each side is applied to a mixer. One half has the in-phase local oscillator applied and the other half has the quadrature oscillator signal applied.



The basic modulator assumes that the two quadrature signals remain exactly in quadrature.

A further requirement is to derive a local oscillator signal for the demodulation that is exactly on the required frequency for the signal. Any frequency offset will be a change in the phase of the local oscillator signal with respect to the two double sideband suppressed carrier constituents of the overall signal.

Systems include circuitry for carrier recovery that often utilizes a phase locked loop - some even have an inner and outer loop. Recovering the phase of the carrier is important otherwise the bit error rate for the data will be compromised.

ALGORITHM

1. Read the image using imread and display the image
2. Convert the image matrix to column matrix
3. Convert the column matrix to binary column matrix
4. Modulate the obtained binary column matrix with qammod/pskmod along with order of modulation
5. Demodulate the received input using qamdemod/pskdemod
6. Reshape the demodulated matrix into matrix having 8 columns, after that convert this matrix to decimal using uint8 and bi2dec.
7. As the image is 256 x 256 reshape the output matrix to 256 x 256 and display the image.
8. Finally display the scatter plot.

MATLAB CODE

1. M PSK

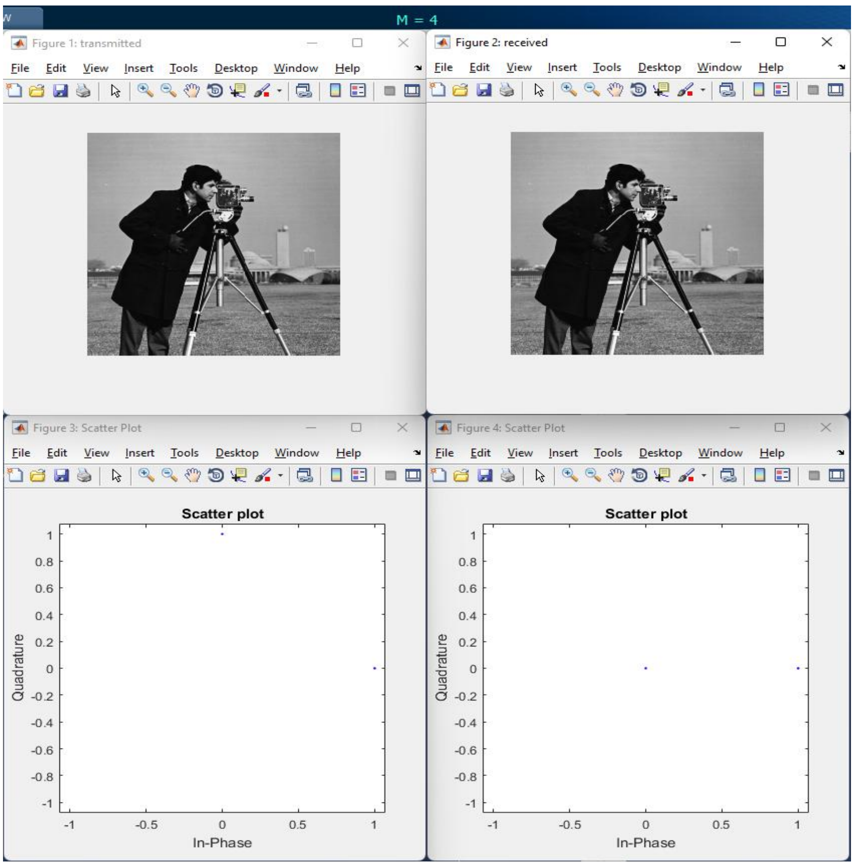
```
clc;
clear all;
close all;
M = 128;
img = imread('cameraman.tif');
figure('name', 'transmitted')
imshow(img);
a = img(:);
b = de2bi(a);
c = double(b);
d = c(:);
y = pskmod(d,M);
e = pskdemod(y,M);
f = reshape(e,[65536,8]);
g = uint8(f);
h = bi2de(g);
x = reshape(h,256,256);
figure('name', 'received')
imshow(x);
scatterplot(y);
scatterplot(e);
```

2. M QAM

```
clc;
clear all;
close all;
img = imread('cameraman.tif');
figure('name', 'transmitted')
imshow(img);
M = 64
a = img(:);
b = de2bi(a);
c = double(b);
d = c(:);
y = qammod(d,M);
e = qamdemod(y,M);
f = reshape(e,[65536,8]);
g = uint8(f);
h = bi2de(g);
x = reshape(h,256,256);
figure('name', 'received');
imshow(x);
scatterplot(y);
scatterplot(e);
```

OUTPUT

1. M PSK



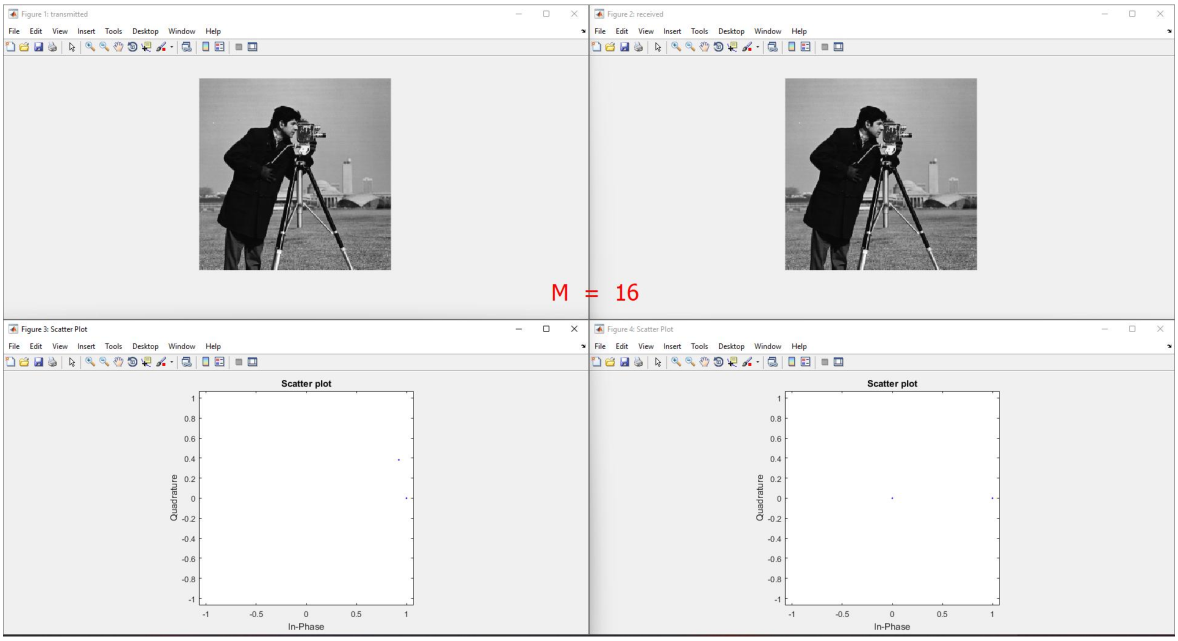


Figure 1: transmitted
Figure 2: received
M = 16
Figure 3: Scatter Plot
Figure 4: Scatter Plot
Scatter plot
Quadrature
In-Phase

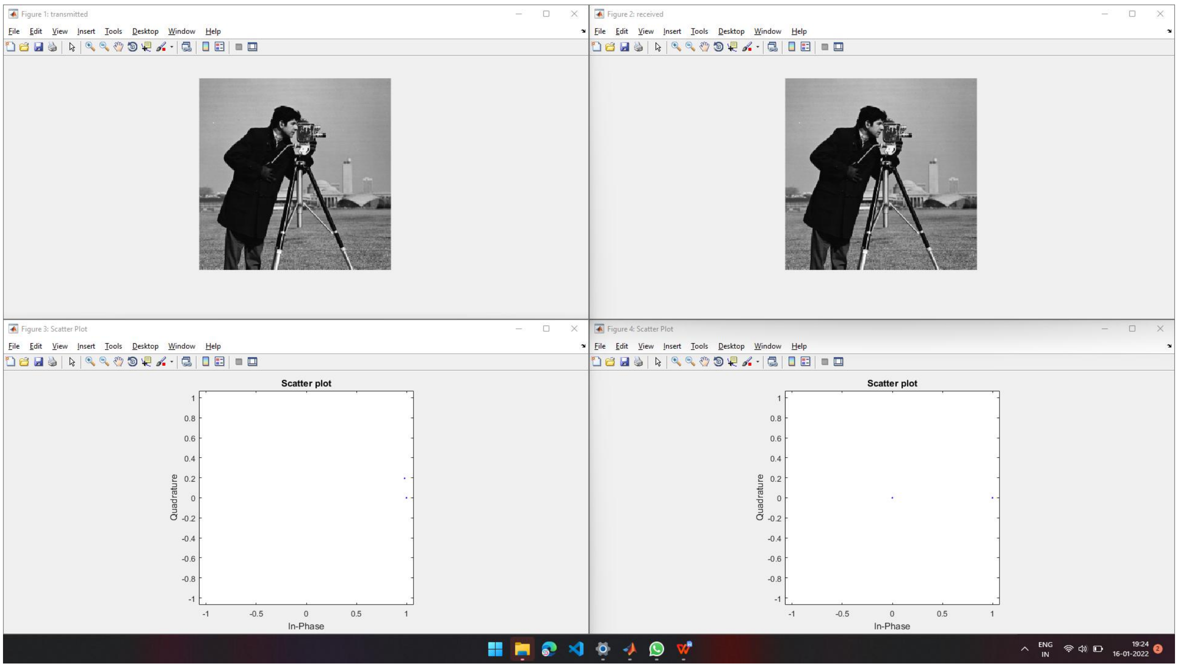


Figure 1: transmitted
Figure 2: received
Figure 3: Scatter Plot
Figure 4: Scatter Plot
Scatter plot
Quadrature
In-Phase

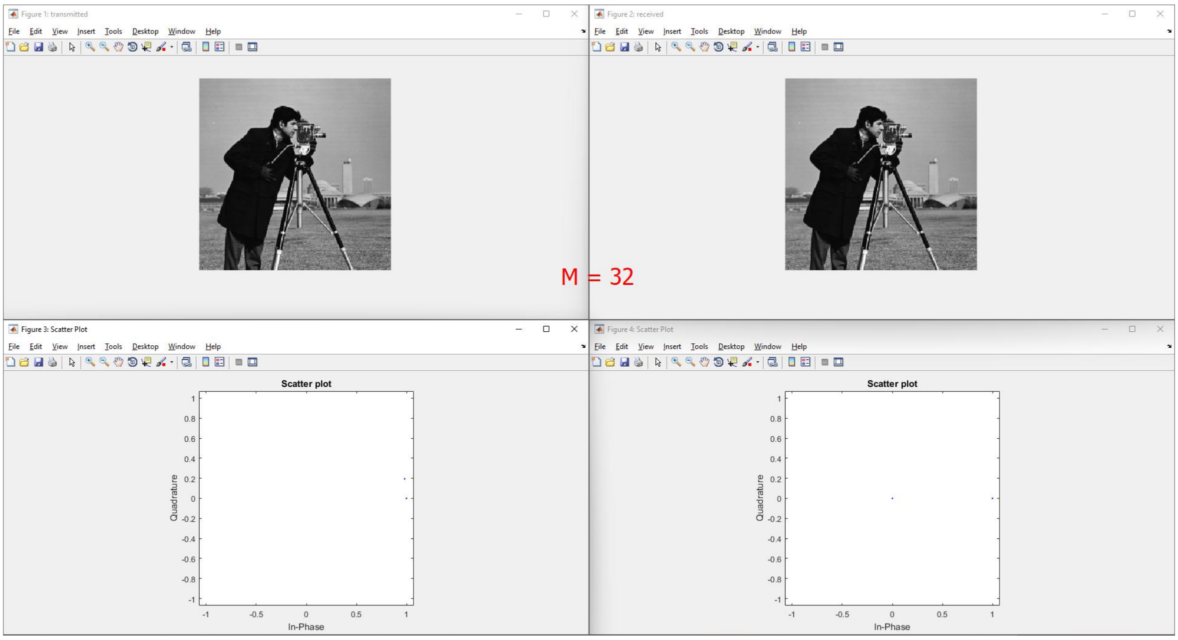


Figure 1: transmitted
Figure 2: received
M = 32
Figure 3: Scatter Plot
Figure 4: Scatter Plot
Scatter plot
Quadrature
In-Phase
Scatter plot
Quadrature
In-Phase

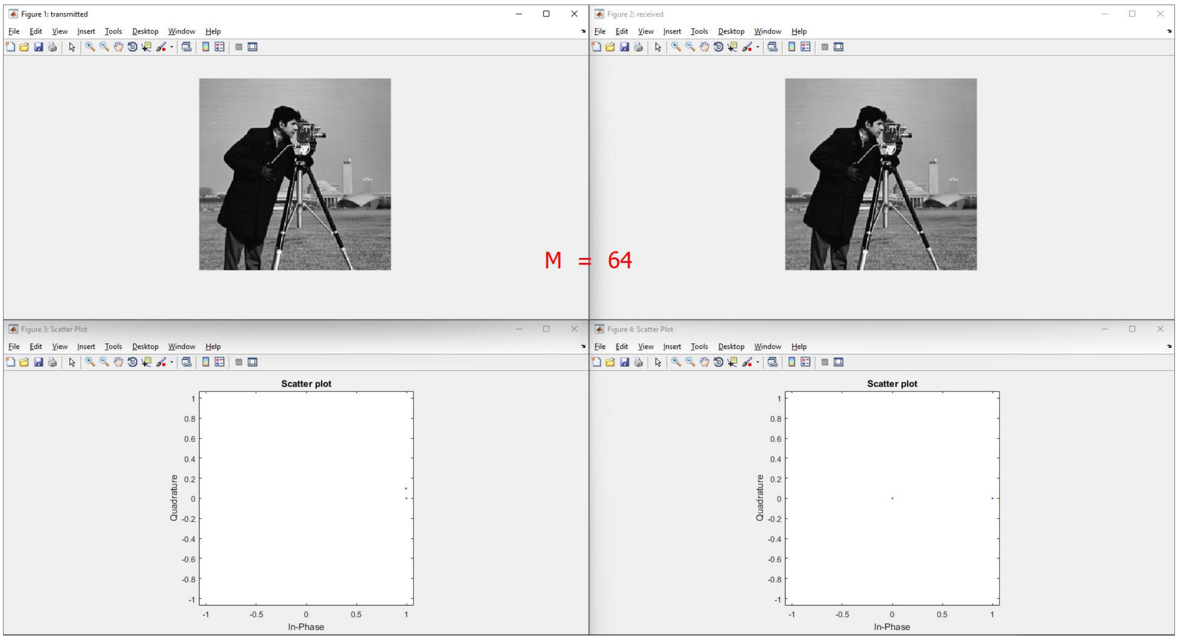


Figure 1: transmitted
Figure 2: received
M = 64
Figure 3: Scatter Plot
Figure 4: Scatter Plot
Scatter plot
Quadrature
In-Phase
Scatter plot
Quadrature
In-Phase

2. M QPSK

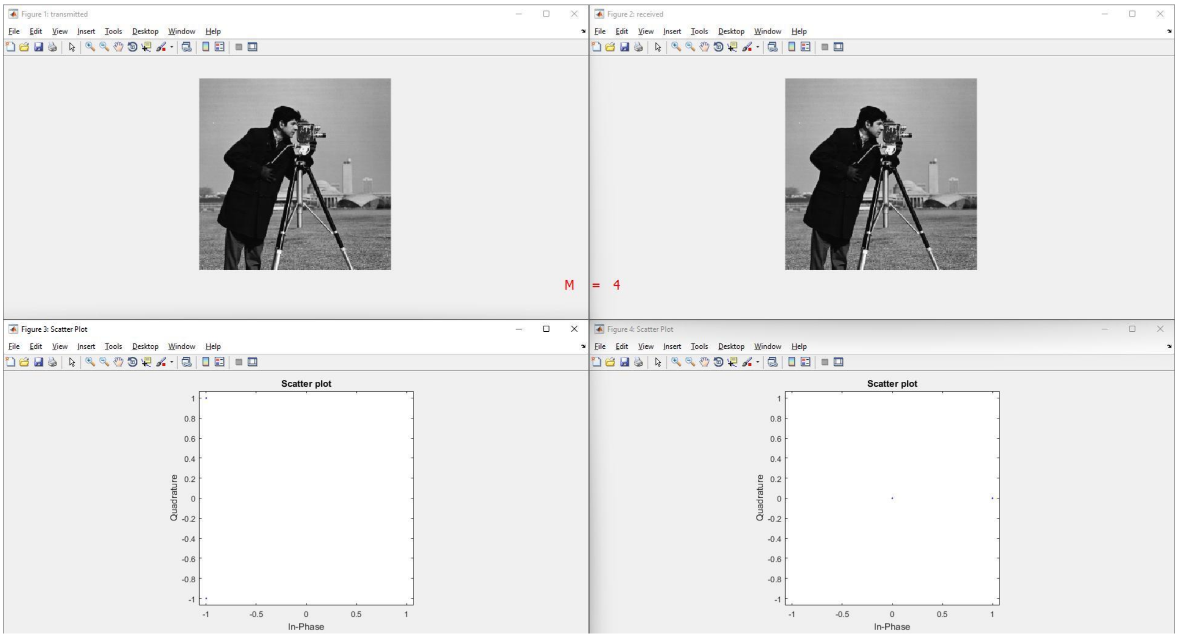


Figure 1: transmitted
Figure 2: received
M = 4
Figure 3: Scatter Plot
Figure 4: Scatter Plot
Scatter plot
Quadrature
In-Phase
Scatter plot
Quadrature
In-Phase

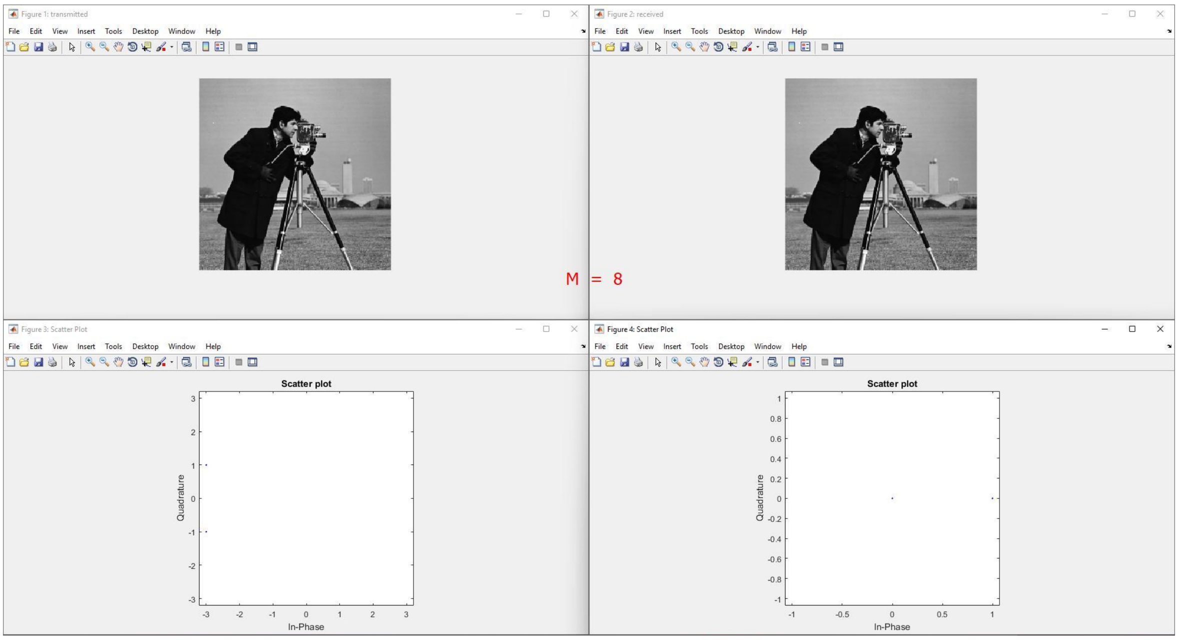


Figure 1: transmitted
Figure 2: received
M = 8
Figure 3: Scatter Plot
Figure 4: Scatter Plot
Scatter plot
Quadrature
In-Phase
Scatter plot
Quadrature
In-Phase

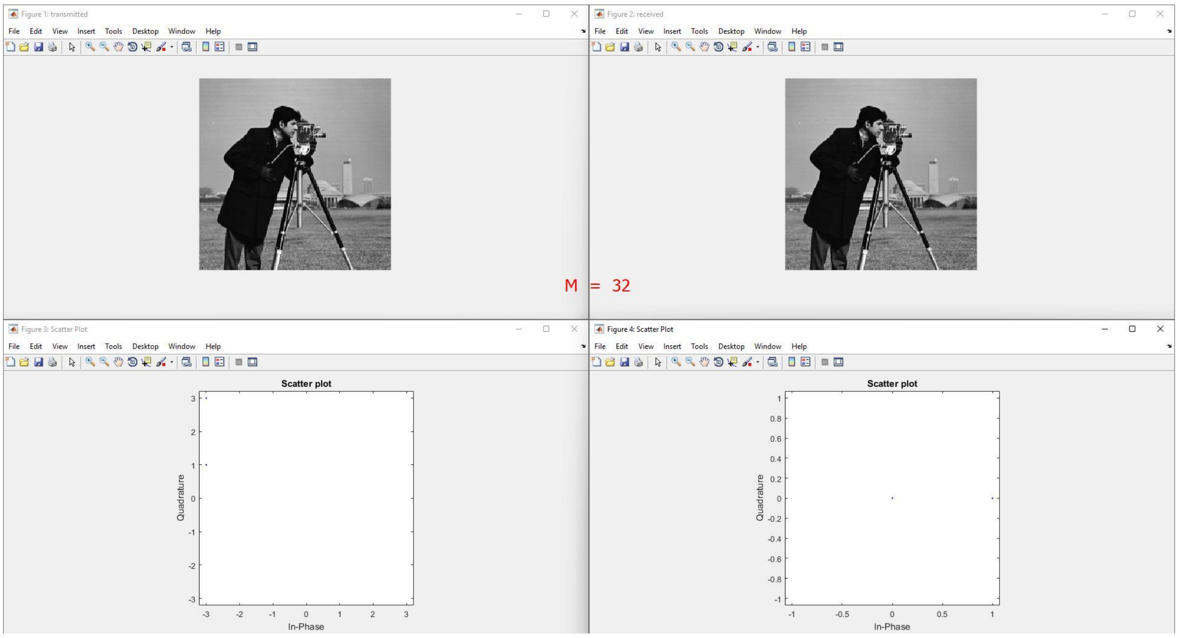


Figure 1: transmitted
Figure 2: received
M = 32
Figure 3: Scatter Plot
Figure 4: Scatter Plot
Scatter plot
Quadrature
In-Phase

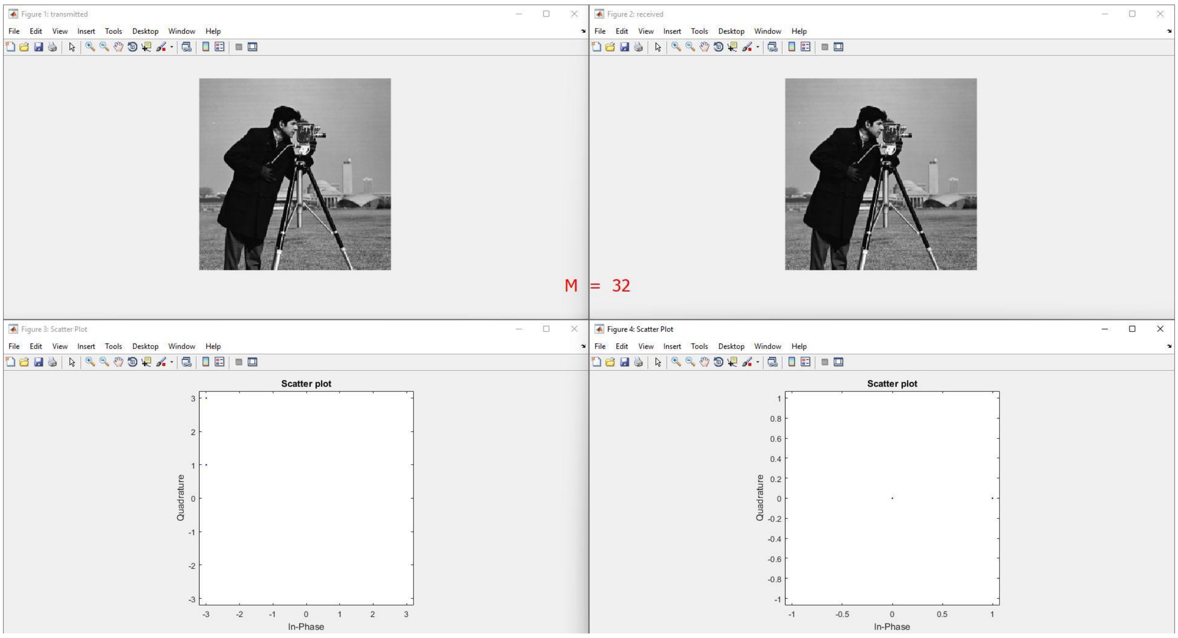
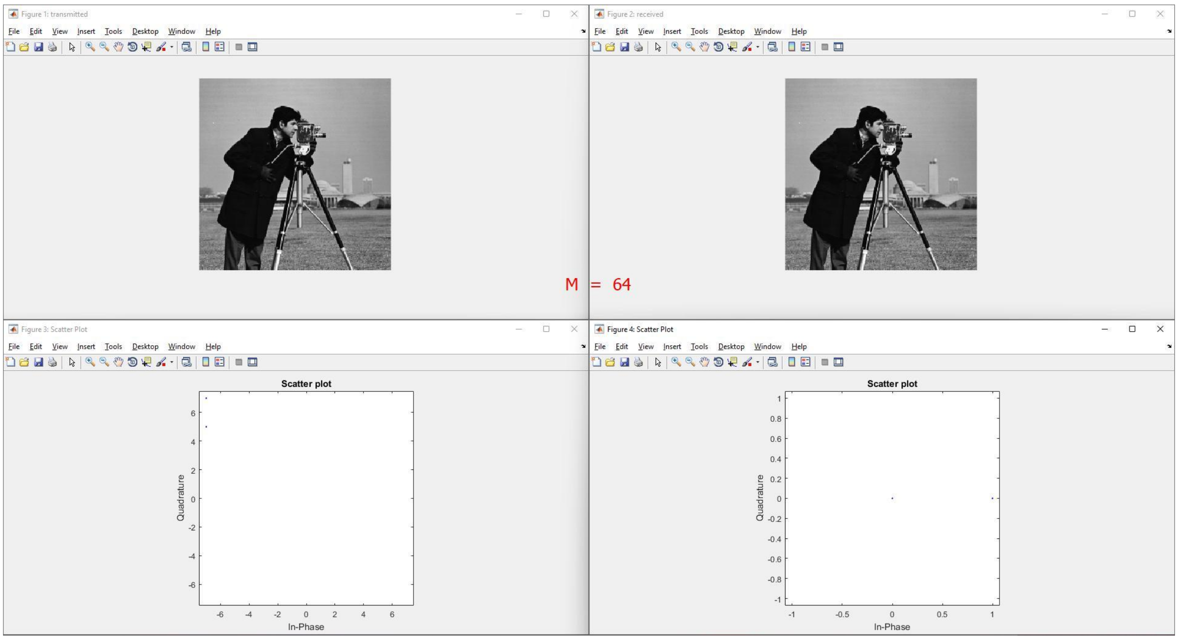


Figure 1: transmitted
Figure 2: received
M = 32
Figure 3: Scatter Plot
Figure 4: Scatter Plot
Scatter plot
Quadrature
In-Phase



CONCLUSION

In this practical we have implemented M-PSK and M-QPSK for various values of M (4, 8, 16, 32 and 64). We have also modulated and demodulated a gray scaled image using MPSK and MQAM.