Experiment - 09

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AIM: Study of 16 QAM Modulation and Demodulation technique with constellation diagram and waveforms.

APPARATUS: MATLAB

THEORY:

1. QAM : Quadrature amplitude modulation or QAM is a form of modulation which is widely used for modulating data signals onto a carrier used for radio communications.

- QAM is a signal in which two carriers shifted in phase by 90° are modulated & the resultant output consists of both amplitude and phase variations.

- Hence, it may also be considered as a mixture of amplitude and phase modulation. QAM is both an analog and digital modulation technique.

2. Main Parameters to be considered while designing any communication system =>
   - Transmission Power
   - Transmission Bandwidth

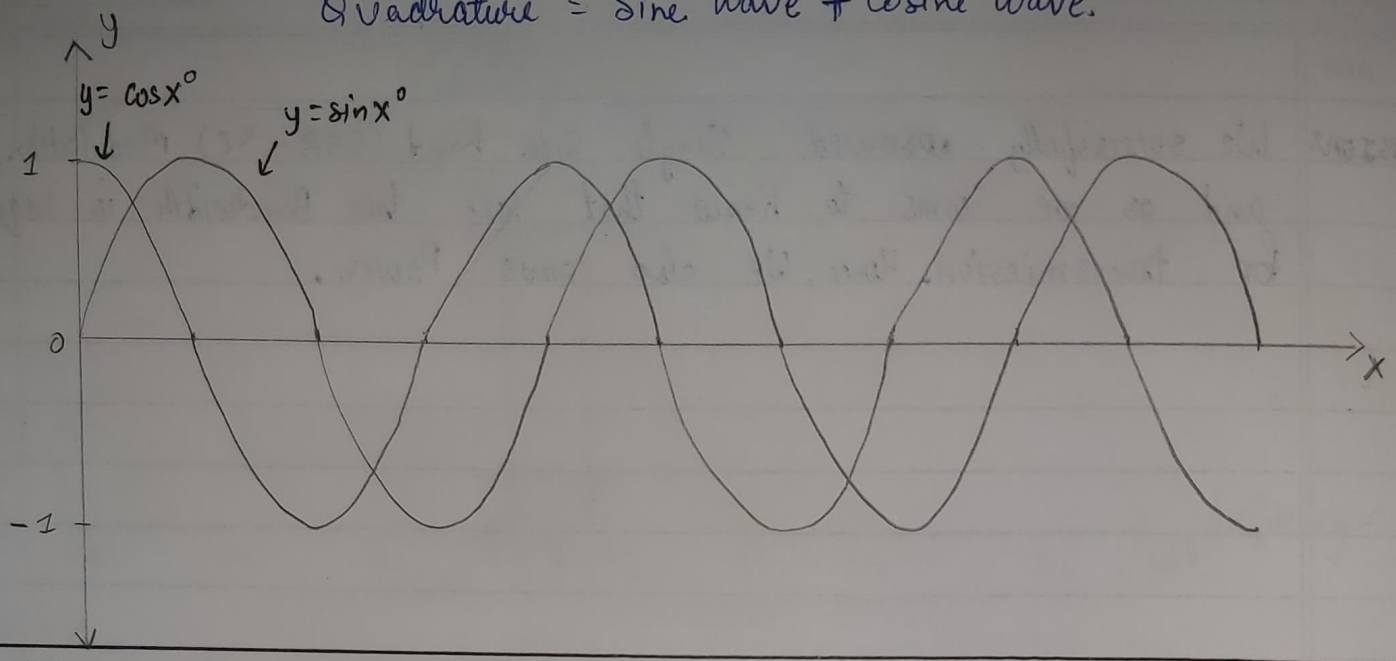
- Although the SSBSC systems are most power and bandwidth efficient but still their performance lags in the noisy environment.

3. Why QAM ?

- The main aim is to save the bandwidth : Two modulated signal occupies the same transmission channel.

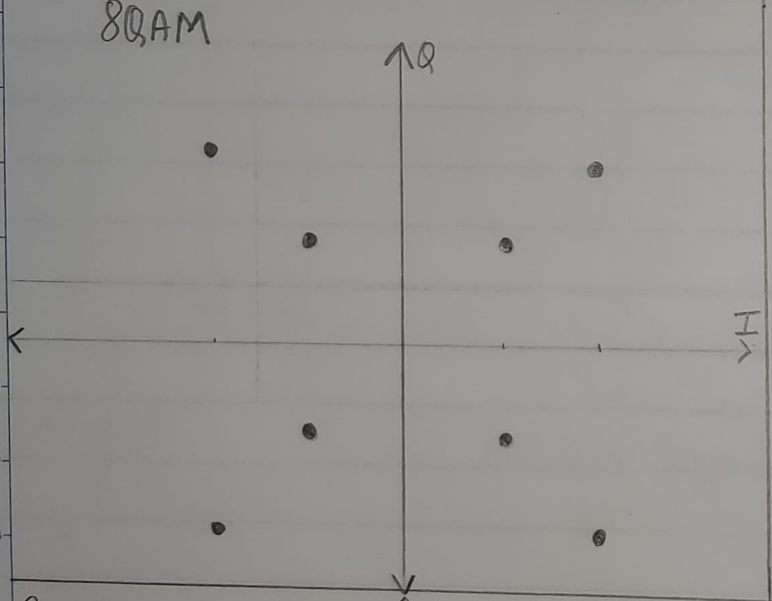
Teacher's Signature :

Quadrature = Sine Wave + Cosine Wave.

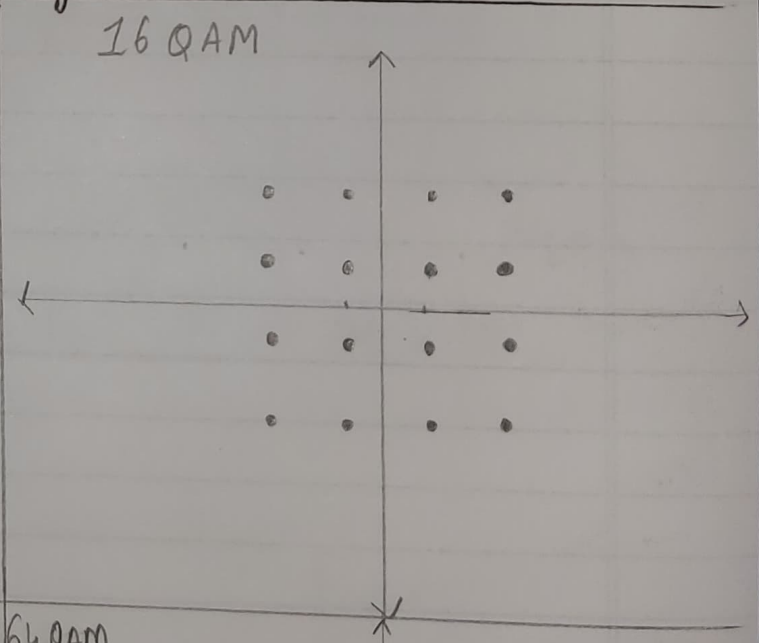


Types of QAM - constellation Diagrams ↓

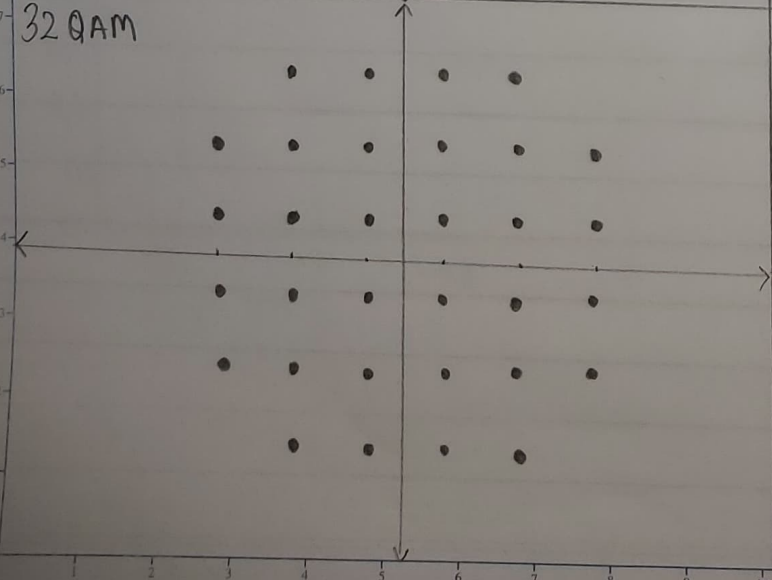
8QAM



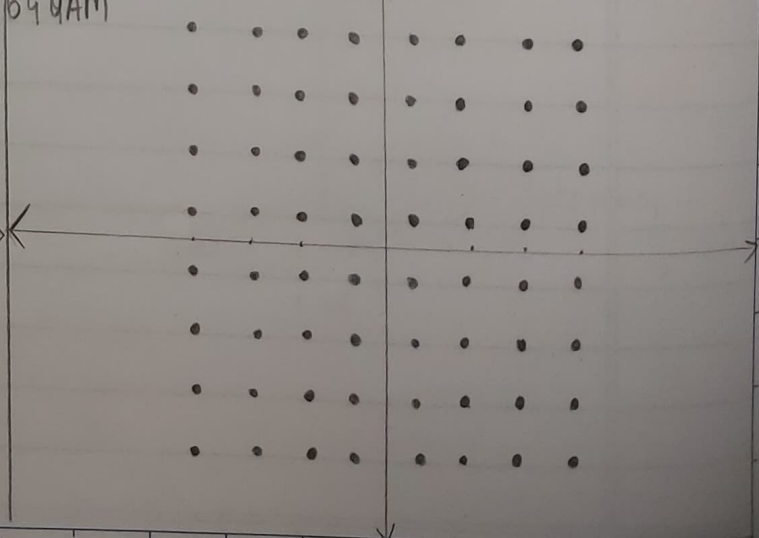
16 QAM



32 QAM



64 QAM



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AIM :

- A motivation for the use of QAM comes from the fact that a straight amplitude modulated signal occupies twice the bandwidth of the modulating signal.

- This is very wasteful of the available frequency spectrum.

- QAM places two independent double sideband suppressed carrier signals in the same spectrum.

4. Types of QAM

- A variety of forms of QAM are available which include.

- 16QAM
- 32QAM
- 64QAM
- 128QAM
- 256QAM.

5. QAM Modulation

- Quadrature amplitude theory states that both amplitude and phase change within a QAM signal.

- The basic way in which a QAM signal can be generated is to generate two signals that are 90° out of phase with each other and then sum them.

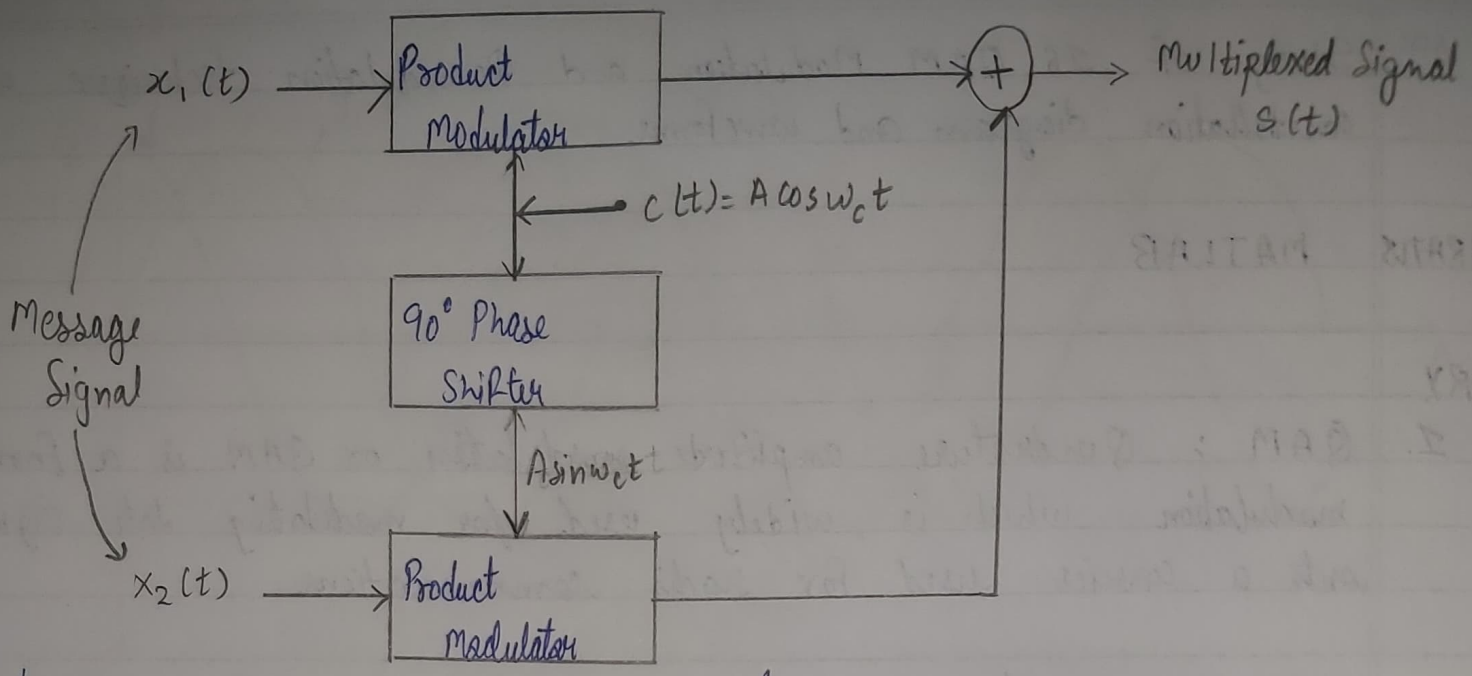
- The I and Q signals can be represented by the equations below:

$$I = A\cos(\varphi)$$

$$Q = A\sin(\varphi)$$

Teacher's Signature : _____

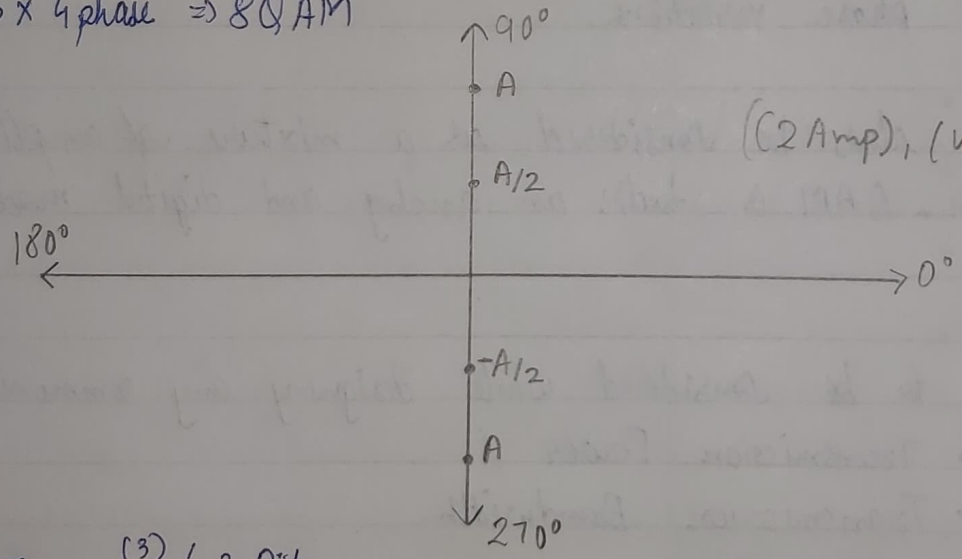
QAM Modulation



$$\{ S(t) = x_1(t) A\cos\omega_c t + x_2(t) A\sin\omega_c t \}.$$

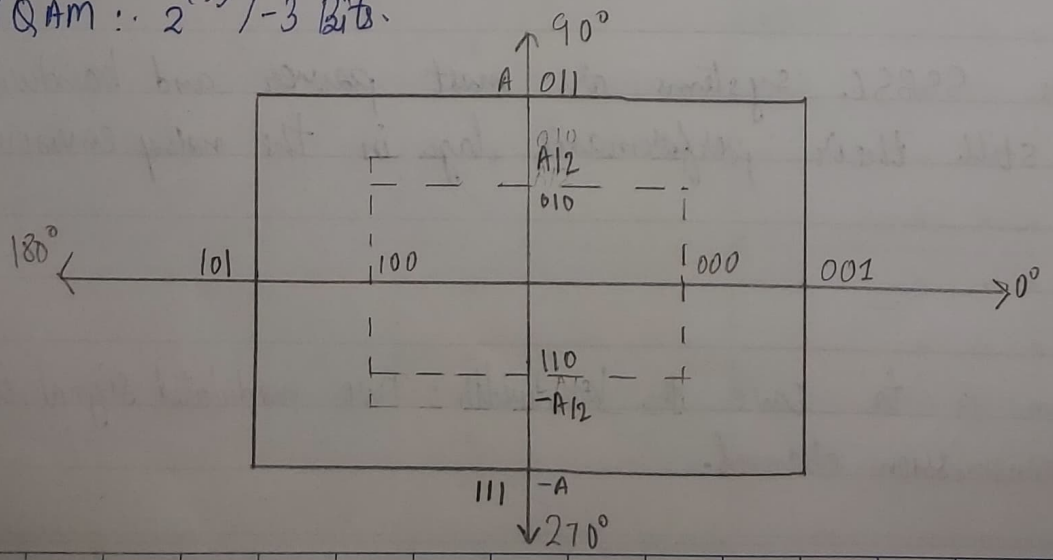
8 QAM Waveforms.

2 Amp × 4 phase ⇒ 8 QAM



((2 Amp), (4 Phase))

8 QAM :. $2^{(3)}$ / 3 Bits.



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AIM :

- This signals will not overlap with eachother because they are orthogonal.
- It is possible to transmit two DSB-SC signals with in a bandwidth of 2 Fm.
- It provide bandwidth efficiency.
- Gives better performance than SSB and also improves data rate.

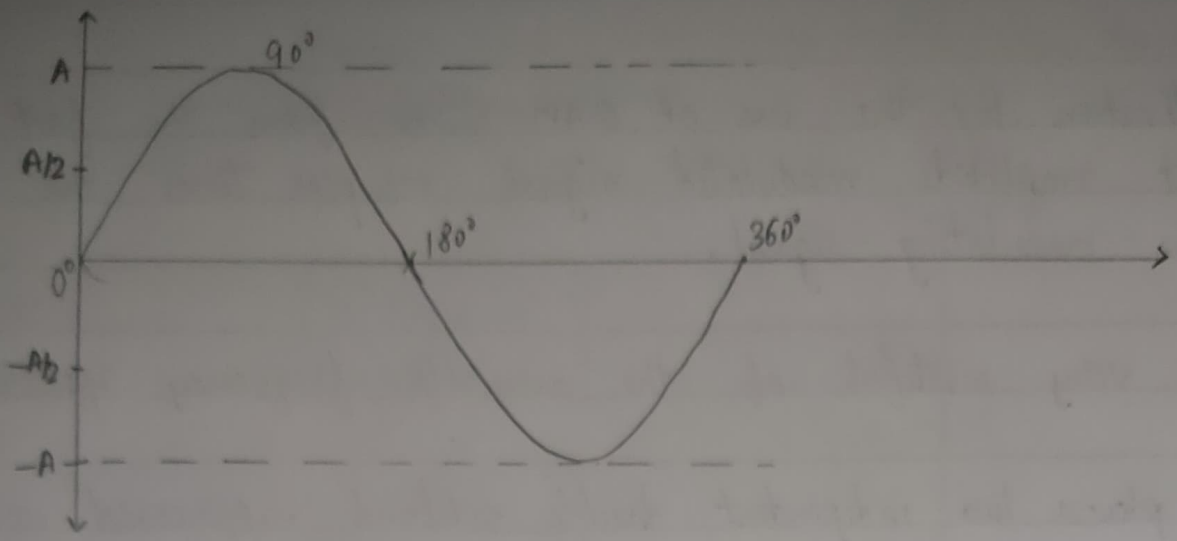
6. QAM Demodulation

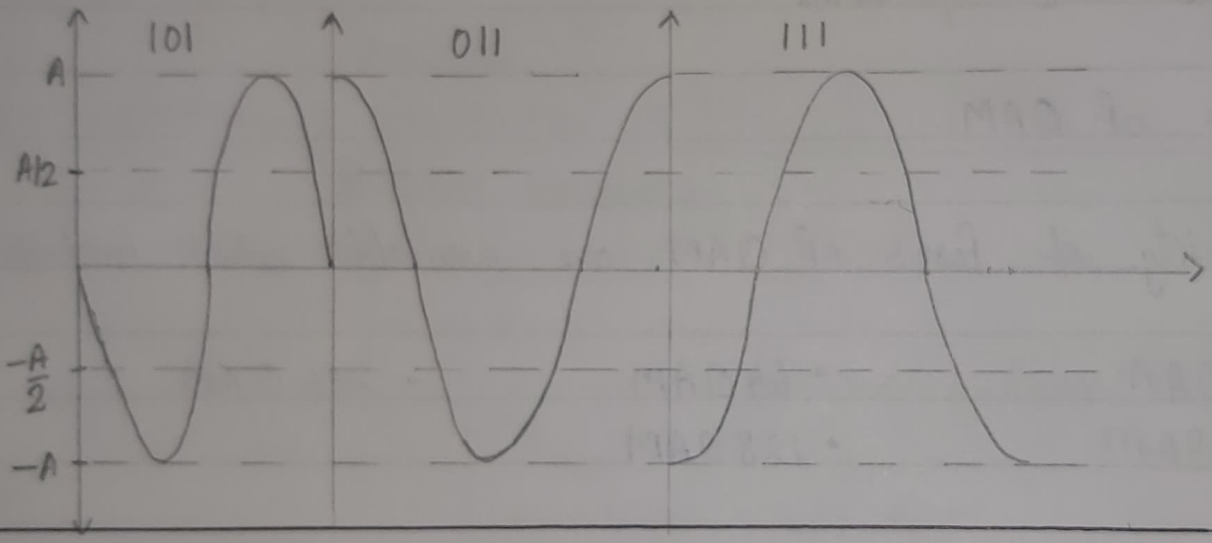
- The QAM demodulator is very much the reverse of the QAM modulator.
- The signals enter the system, they are split and each side is applied to a mixer.

7. Bit error Rate (Received Bits)

- While higher order modulation rates are able to offer much faster data rates and higher levels of spectral efficiency for the radio communications system, this comes at a price.
- The higher order modulation schemes are considerably less resilient to noise and interference.

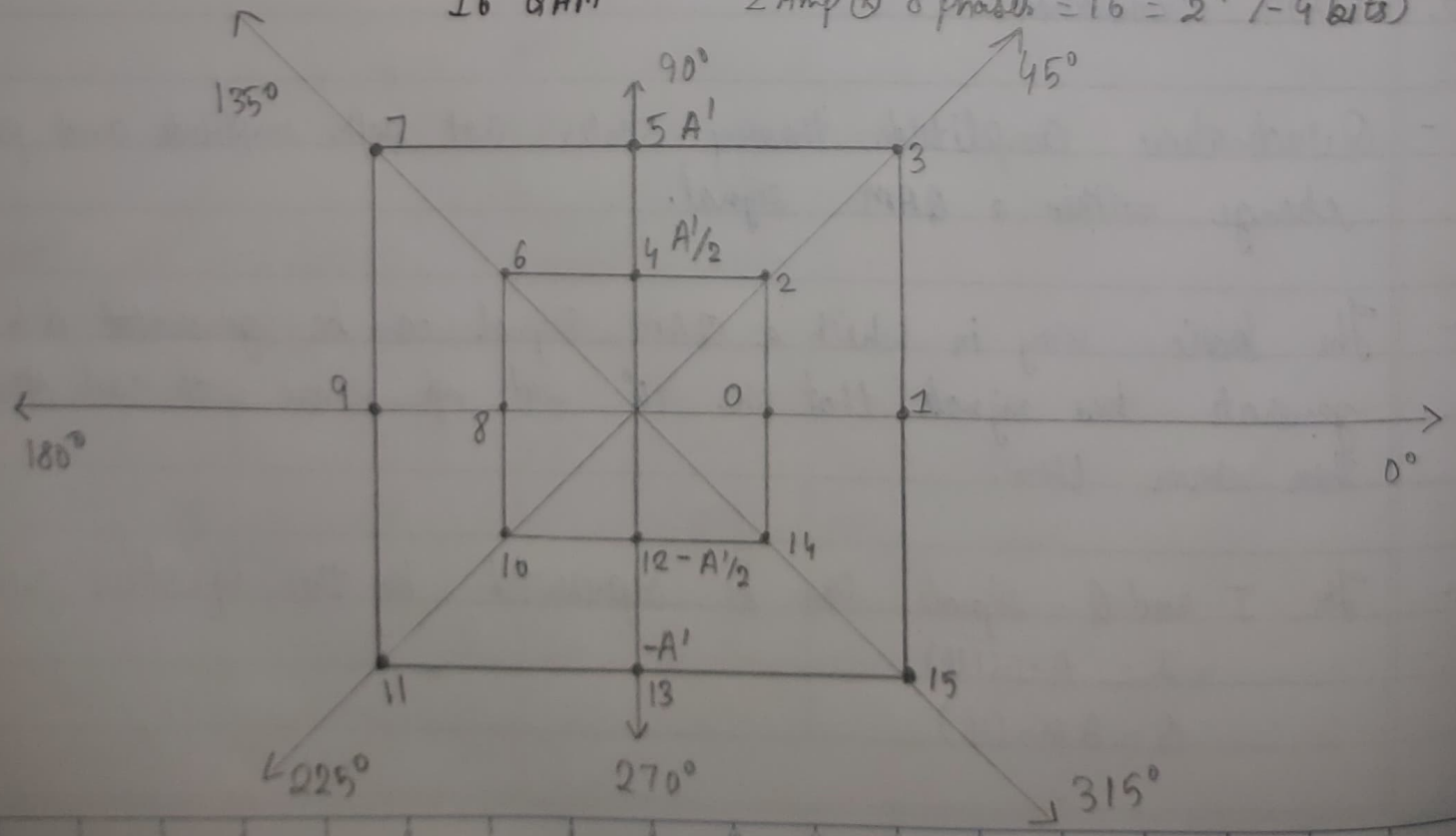
Phasor Diagram





16 QAM

2 Amp ⊗ 8 phases = 16 = 2^4 (4 bits)



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AIM :

- Many radio communications systems now use dynamic adaptive modulation techniques. They sense the channel conditions and adapt the modulation scheme to obtain the highest data rate for the given conditions.

- M-QAM technique provide better bit error rate performance than M-PSK modulation techniques.

8. Advantages

- The advantage of using QAM is that it is a higher order form of modulation. As a result it is able to carry more bits of information per symbol.

- By selecting a higher order format of QAM, the data rate of a link can be increased.

- Bit rate is increased without increasing the bandwidth.

9. Applications

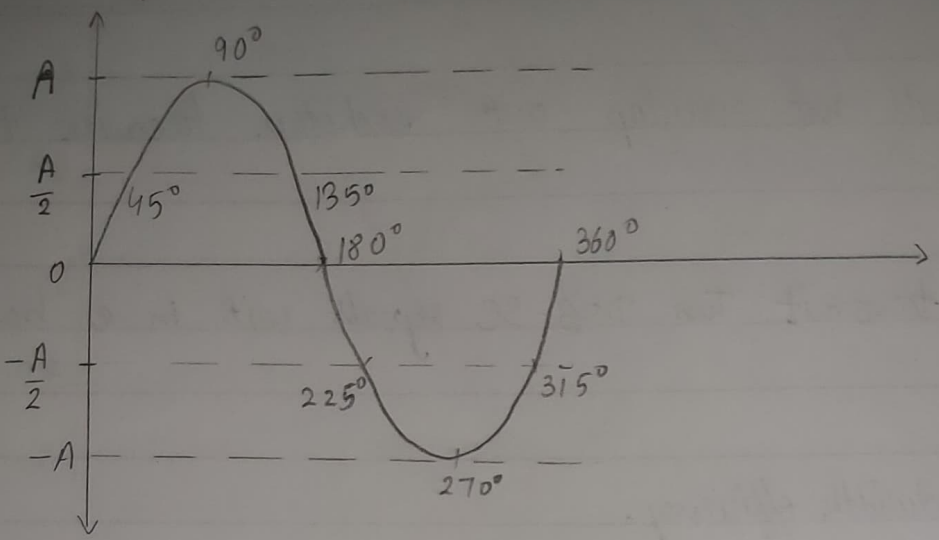
- Quadrature multiplexing is used in color television to multiplex the so-called chrominance signals which carry the information about colors.

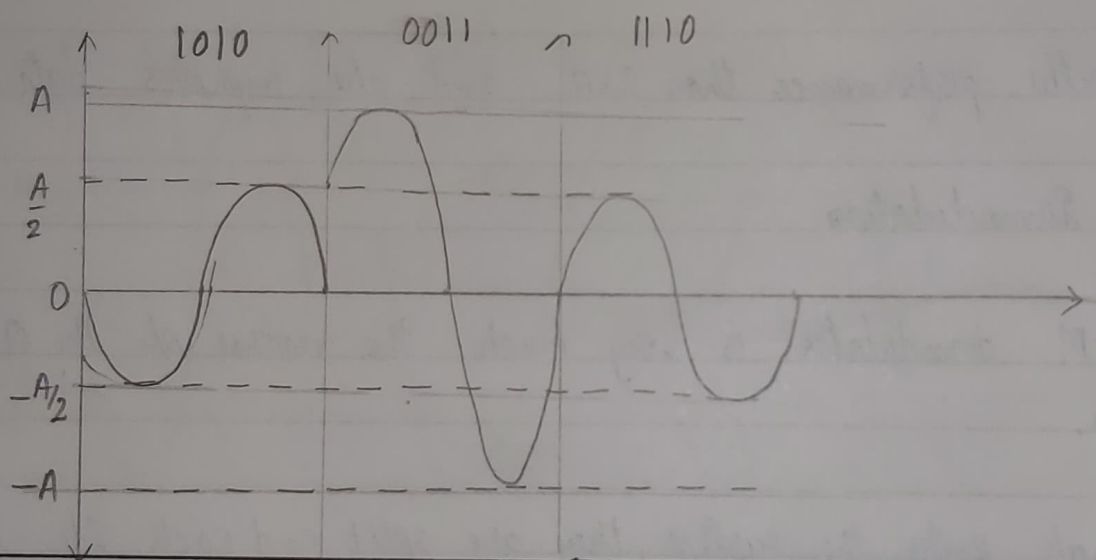
- QAM Scheme is used on telephone lines for data transmission.

- Ultra-high capacity Microwave Backhaul Systems also use 1024-QAM.

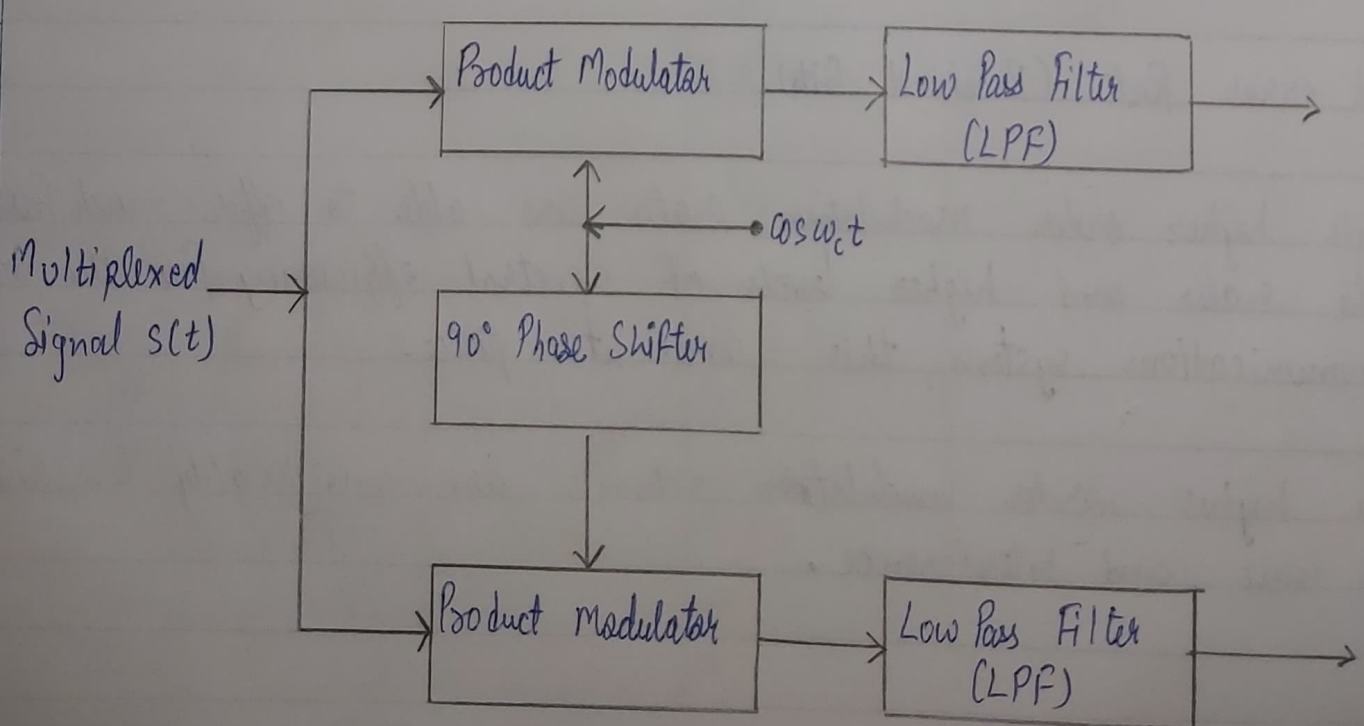
Teacher's Signature : _____

Phasor Diagram.





QAM Demodulation.



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AIM :

CONCLUSION: We successfully examined the 16-Quadrature Amplitude Modulation (16-QAM) and demodulation scheme. We also evaluated 16 BER values for different QAM using MATLAB.

Teacher's Signature : _____

Modulation	Bits Per Symbol	Symbol Rate
BPSK	1	1 x bit rate
QPSK	2	1/2 bit rate
8PSK	3	1/3 bit rate
16 QAM	4	1/4 bit rate
32QAM	5	1/5 bit rate
64 QAM	6	1/6 bit rate

"BER values" using MATLAB