EXPERIMENT NO. 7

AIM: **To Simulate and study of Performance of M-ary PSK.**

OBJECTIVE: Write a MATLAB code for M ary PSK.

SOFTWARE: MATLAB Software version________

THEORY:

The word binary represents two bits. M represents a digit that corresponds to the number of conditions, levels, or combinations possible for a given number of binary variables.

This is the type of digital modulation technique used for data transmission in which instead of one bit, two or more bits are transmitted at a time. As a single signal is used for multiple bit transmission, the channel bandwidth is reduced.

M-ary Equation

If a digital signal is given under four conditions, such as voltage levels, frequencies, phases, and amplitude, then M = 4.

The number of bits necessary to produce a given number of conditions is expressed mathematically as

$$N=log2M$$

Where

N is the number of bits necessary

M is the number of conditions, levels, or combinations possible with N bits.

The above equation can be re-arranged as

$$2N=M$$

For example, with two bits, 22 = 4 conditions are possible.

Types of M-ary Techniques

In general, Multi-level M−ary modulation techniques are used in digital communications as the digital inputs with more than two modulation levels are allowed on the transmitter's input. Hence, these techniques are bandwidth efficient.

There are many M-ary modulation techniques. Some of these techniques, modulate one parameter of the carrier signal, such as amplitude, phase, and frequency.

M-ary PSK

This is called as M-ary Phase Shift Keying M−ary PSK

The phase of the carrier signal, takes on M different levels.

Representation of M-ary PSK:

Multi-level modulation techniques permit high data rates within fixed bandwidth constraints. A convenient set of signals for M-ary PSK is

$$\phi_i(t) = A\cos(\omega_c t + \theta_i), \qquad 0 < t \le T_s,$$

where the M phase angles are

$$\theta_i = 0, \frac{2\pi}{M}, \ldots, \frac{2(M-1)\pi}{M}.$$

For equiprobable ones and zeros the PSD for M-ary PSK is

$$S_\phi(\omega) = A^2 T_s \mathrm{Sa}^2\left[(\omega - \omega_c)\frac{T_s}{2}\right].$$

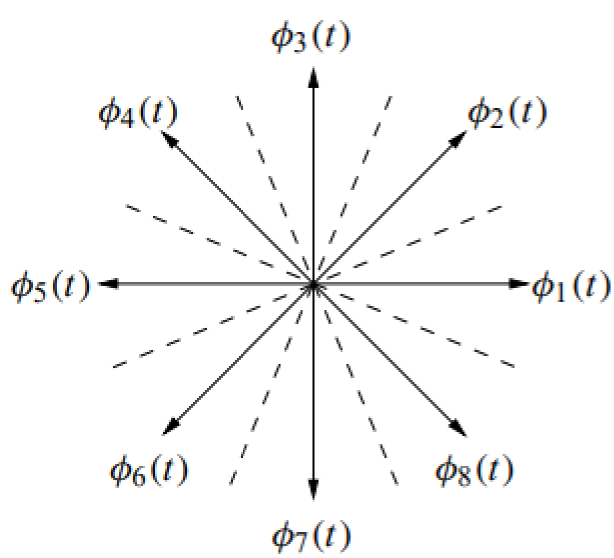
The symbols in this case are of duration T_s, so the information (or bit) rate T_b satisfies

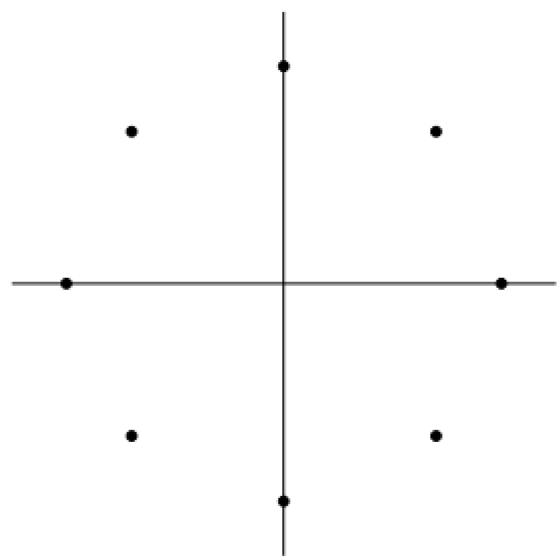
$$T_s = T_b \log_2 M.$$

The potential bandwidth efficiency of M-ary PSK can be shown to be

$$\frac{f_b}{B} = \log_2 M \text{ bps/Hz}.$$

A phase diagram and signal constellation diagram for the case of $M = 8$ are shown below:





All signals have the same energy E_s over the interval $(0, T_s)$, and each signal is correctly demodulated at the receiver if the phase is within $\pm\pi/M$ of the correct phase θ_i. No information is contained in the energy of the signal.

A probability of error calculation involves analysing the received phase at the receiver (in the presence of noise), and comparing it to the actual phases. An exact solution is difficult to compute, but for $P_\epsilon < 10^{-3}$ an approximate probability of making a symbol error is

$$P_\epsilon \approx 2\mathrm{erfc}\sqrt{\frac{2E_s}{\eta}\sin^2\frac{\pi}{M}}, \qquad M > 2.$$

If a Gray code is used, then the corresponding bit error is approximately

$$P_{\mathrm{be}} \approx P_\epsilon / \log_2 M.$$

Stremler provides a table of the SNR requirements of M-ary PSK for fixed error rates. The results indicate that for QPSK ($M = 4$) has definite advantages over coherent PSK ($M = 2$) — the bandwidth efficiency is doubled for only about a 0.3dB increase in SNR. For higher-rate transmissions in bandlimited channels the choice $M = 8$ is often used. Values of $M > 8$ are seldom used due to excessive power requirements.

M-ary PSK requires more complex equipment than BPSK signalling. Carrier recovery is also more complicated. The requirement that the carrier be recovered can be mitigated by using a comparison between the phases of two successive symbols. This leads to M-ary *differential* PSK, and is in principle similar to DPSK (which is differential PSK for $M = 2$).

For large SNR the probability of error is

$$P_\epsilon \approx 2\mathrm{erfc}\sqrt{\frac{2E_s}{\eta}\sin^2\frac{\pi}{\sqrt{2M}}}.$$

Thus differential detection increases the power requirements by the factor

$$\Gamma = \frac{\sin^2 \pi/M}{\sin^2(\pi/\sqrt{2M})}$$

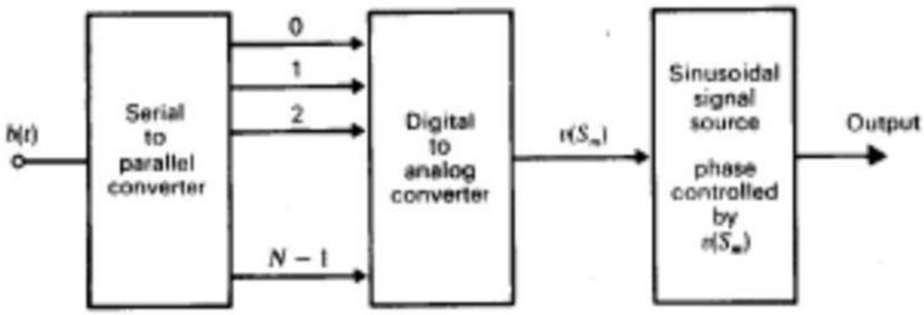
For $m = 4$, the increase is required power is about 2.5dB, which may be justified by the saving in equipment complexity.

Some prominent features of M-ary PSK are −

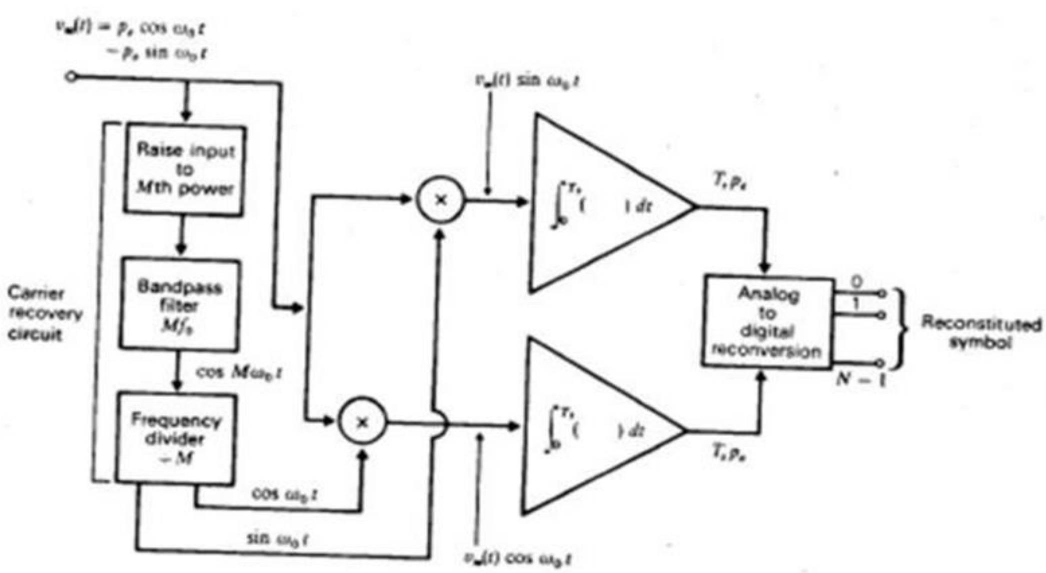
- The envelope is constant with more phase possibilities.
- This method was used during the early days of space communication.
- Better performance than ASK and FSK.
- Minimal phase estimation error at the receiver.
- The bandwidth efficiency of M-ary PSK decreases and the power efficiency increases with the increase in M.

So far, we have discussed different modulation techniques. The output of all these techniques is a binary sequence, represented as 1s and 0s.

Transmitter of M-ary PSK :



Receiver of M-ary PSK:



Flowchart:

Algorithm:

Program:

Input,

Output,

Result:

Questions:

1. What is Mary PSK?
2. Difference between BPSK, QPSK and Mary PSK?
3. Calculate the Bandwidth of Mary PSK?

Conclusion:

Timely submission (10)	Journal Presentation(10)	Performance(10)	Understanding(10)	Oral(10)	Total (50)
Sub Teacher Sign:					