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

$$N=\log 2M$$

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

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

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

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

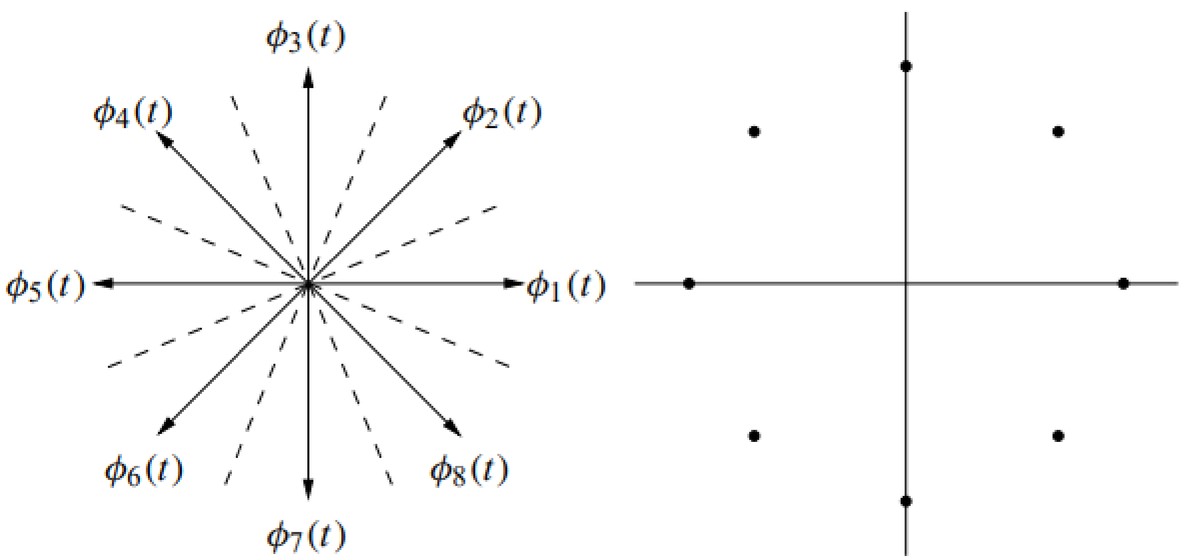
The symbols in this case are of duration T_s, so the information (or bit) rate T_b satisfies

$$T_s = T_b \log_2 M.$$

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

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

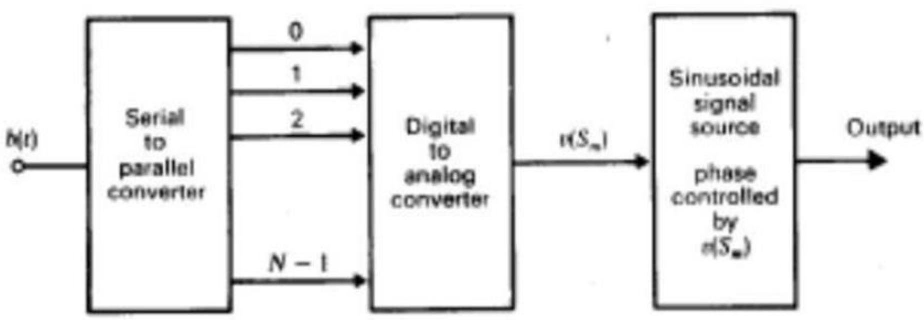
For $m = 4$, the increase is required power is about 2.5dB, which may be justified by the saving in equipment complexity.

Some prominent features of M-ary PSK are −

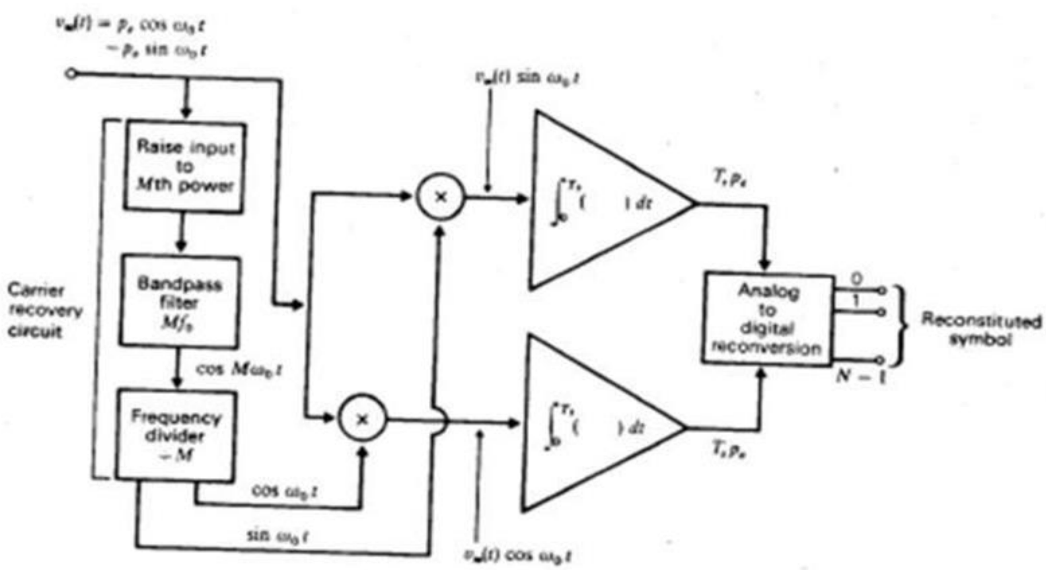
- The envelope is constant with more phase possibilities.
- This method was used during the early days of space communication.
- Better performance than ASK and FSK.
- Minimal phase estimation error at the receiver.
- The bandwidth efficiency of M-ary PSK decreases and the power efficiency increases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

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

EXPERIMENT NO. 4

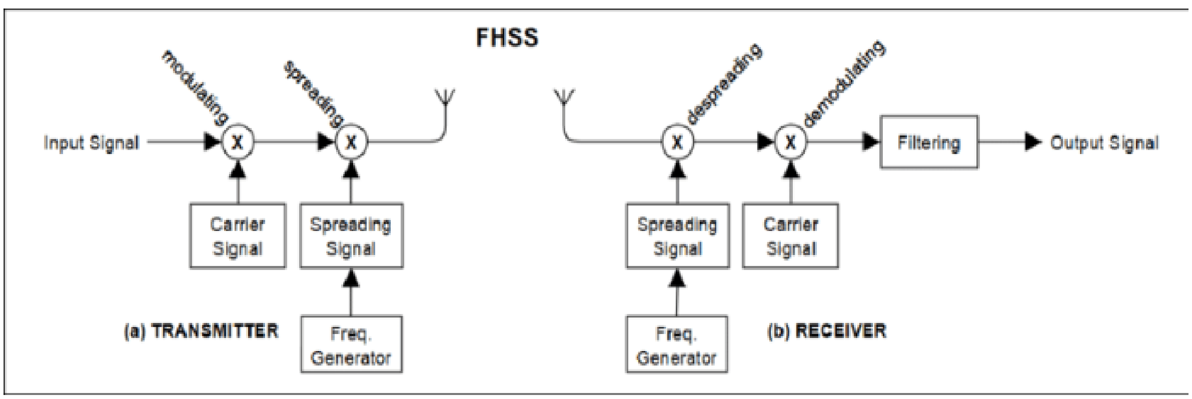
AIM: Study of FH-SS transmitter and receiver using suitable hardware setup/kit.

OBJECTIVE: Experimental Study of Generation &detection of FH-SS coherent BPSK & its spectrum

APPARATUS: FH-SS kit, DSO, CRO, Connecting wires.

THEORY: -

In Frequency Hoping Spectrum, available channel bandwidth is broken into a large number of non-overlapping frequency slots. Data is modulated onto time-varying, Pseudo random carrier frequencies. Transmitter "hops" between different narrowband Channels with centre frequency fi, and bandwidth B (instantaneous bandwidth). Spectrum BW (bandwidth) over which hopping occurs is called the total hopping. Data sent by hopping transmitter carrier to seemingly random channels which are known only to desired receiver. On each channel, data bursts are sent using conventional narrowband modulation hopping period/hop duration. There are generally two types of hopping schemes employed in FHSS.

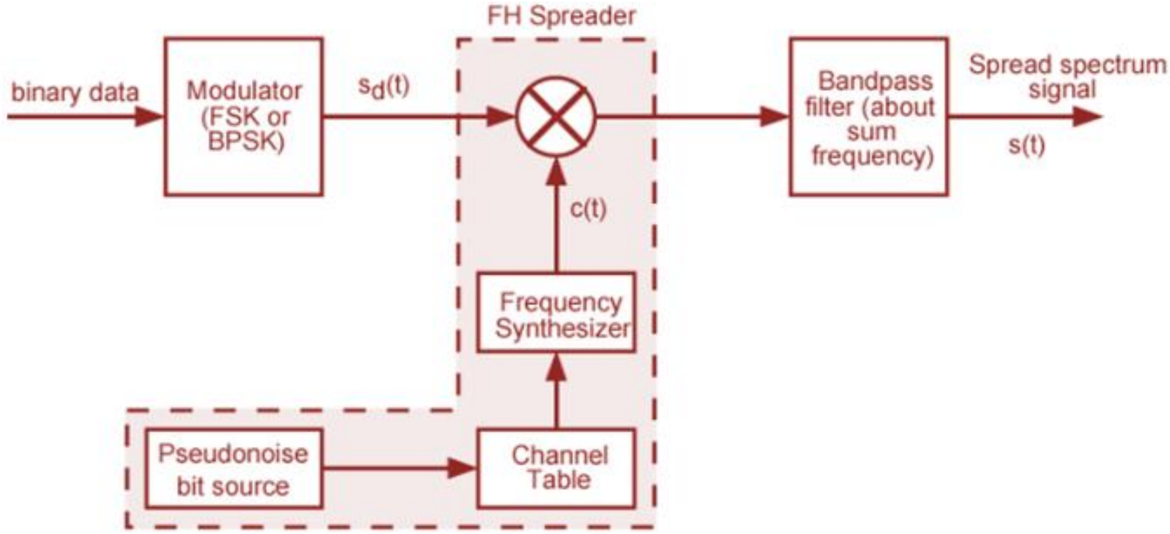


Fast Hopping: In this scheme the hopping rate is kept equal to or greater than the Data rate. The hopping rate should not be many time faster than the data rate. Generally, it can be 2-3 times faster than the data rate.

Slow Hopping: In this scheme the hopping rate is kept lower than the data rate. Also, the data rates which can be supported by FHSS system are quite lower than the data rates supported by DSSS systems.

FH-SS Transmitter:

FHSS is a method of transmitting radio signals by rapidly switching a carrier among many frequency channels, using a pseudorandom or pseudonoise sequence known to both transmitter and receiver. The advantage of this system is that the signal sees a different channel and a different set of interfering signals during each hop.

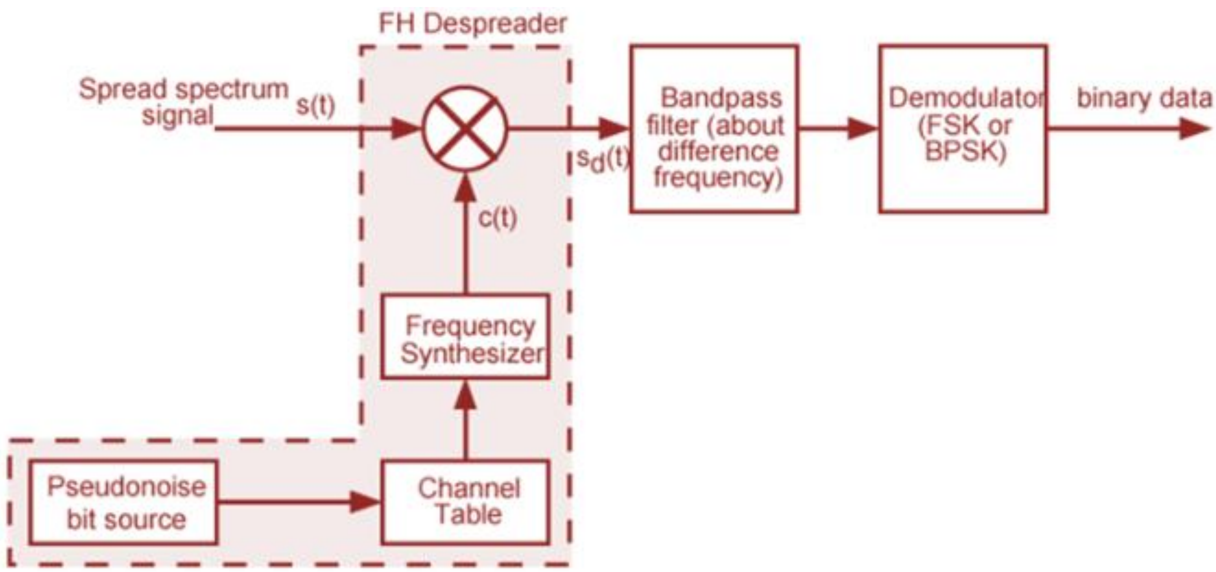


FHSS Transmitter

This system helps to avoid the problem of failing communication at a particular frequency, because of a fade or a particular or unintentional interference.

It is utilized as a multiple access method in the frequency-hopping Code Division Multiple Access (FH-CDMA) schemes.

FHSS is also useful to counter eavesdropping, as well as to obstruct the frequency jamming of telecommunications.



FHSS Receiver

The above figure shows the Block diagram of the FHSS system for both transmitter and receiver.

For transmission, binary data are fed into a modulator using some digital-to-analog encoding scheme, such as Frequency Shift Keying (FSK) or Binary Phase Shift Keying (BPSK).

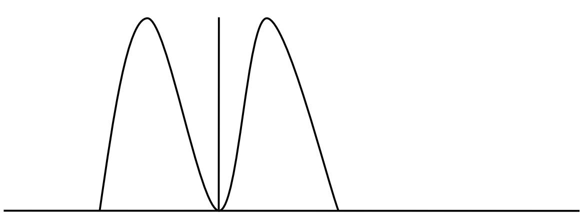
A PN source serves as an index into a table of frequencies each K bit on the PN source specifies one of the 2k carrier frequencies.At each successive interval, a new carrier frequency is selected. This frequency is then modulated by the signal produced from the initial modulator to produce a new signal with the same shape.On reception, the spread spectrum signal is demodulated using the same sequence of PN-derived frequencies and then demodulated to produce the output data.

Frequency hopping is a FM or FSK technique. The signal to be frequency hopped is usually a BFSK signal. In computer peripheral & radio (wireless) communications, the binary data or code is transmitted by means of a carrier frequency that is shifted between two preset frequencies. Since a carrier frequency is shifted between two preset frequencies, the data transmission is said to use a frequency shift keying technique. We get (fc + df) for logic ‘0’ & (fc-df) for logic ‘1’ of i/p data to be transmitted. For example if fc=2KHz, we get 1950Hz for logic ‘1’ & 2050Hz for logic ‘0’.

The FH modulation is then applied by varying the carrier frequency. The carrier frequency changes at hopping rate after TH seconds. Normally TH is equal to or more than bit period of i/p data signal. The frequency chosen for each TH is selected in a pseudo random manner from a specified set of frequencies

The primary advantage of FH is that it enables the transmitter to change it’s carrier frequency & thereby avoid an in-band interfering signal .
e.g.In Military system ,the interferer detects the signal carrier freq. & purposely transmits at that freq. to block or jam the communication. By employing FH & using no of frequencies , the probability of the same interferer causing an error is reduced.Also as transmitter changes carrier at pseudo random manner , it is possible to detect signal if & only if the receiver also switches carrier in same pseudo random manner. Otherwise it is not possible to detect signal. Thus secrecy is also maintained.

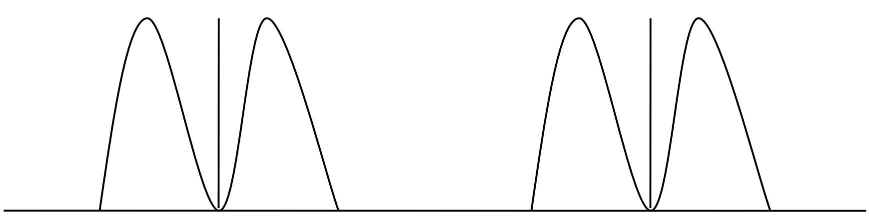
Fc



Spectrum for FSK

:------- 4Fb ------- : B.W= 4* fb

Fc1 ---------------------------- Fcn



: -----4 Fb -------- : ------------:--------4 fb---------:

Spectrum for FHSS B.W = 4*n *Fb

Working :-

In our kit we have provided two carrier frequencies fc1 & fc2. In practical sustems no .of frequencies are very large. But as it is a trainer kit for understanding purpose we have used only two frequencies.

The carrier freq. is determined by PN sequence. We have used 4-Bit PN sequence. It repeats after 2 4 -1 = 15 clock cycles. If o/p of PN seq. is at logic '0' then fc1 is selected & if o/p of PN seq. is at logic '1' then fc2 is selected.

This fc1 or fc2 is then generates FSK signal depending on logic level of i/p DATA pattern.

We have provided 2 Bit patterns. FSK generator is designed using XR2206 & demodulator using XR 2211. Refer to cct diagram & block diagram. Detail working of FSK is already covered in FSK MODEM kit & working of PN seq. is also covered in 4-Bit PN sequence kit.

PROCEDURE:-

1) Switch on the power supply.

2) Observe P1, P2 ,PN seq, o/p on CRO.

A]

I) First connect PN I/P of FHSS Modulator & FHSS Demodulator to GND i.e. logic '0'

II) Connect either P1 or P2 to Pattern i/p of FHSS Modulator.

III) observe o/p of FHSS Modulator . It is FSK at Fc1.

IV) Observe exaggerated FSK by varying pot (Frequency Shift Pot) & then keep it at minimum position

V) Connect o/p of FHSS Modulator to FHSS Demodulator.

VI) Observe o/p of FHSS Demodulator & adjust POT 1 to get proper detected o/p . [Do not vary POT 1 here onwards.]

B]

I) Now connect PN I/P of FHSS Modulator & FHSS Demodulator to '5V' i.e. logic '1' [All other connections unchanged.]

II) observe o/p of FHSS Modulator. It is FSK at Fc2

Observe o/p of FHSS Demodulator & adjust POT 2 to get proper detected o/p . [Do not vary POT 2 here onwards]

C]

I) Now connect PN I/P of FHSS Modulator to PN sequence o/p & PN I/P FHSS Demodulator Kept open

II) observe o/p of FHSS Modulator. We will get FSK at Fc1 or Fc2 varying randomly.

III) Observe o/p of FHSS Demodulator. We will not get proper detected o/p as we have not connected PN seq. to FHSS Demodulator.

IV) Now Connect PN sequence to PN i/p of FHSS demodulator

V) Observe Detected o/p.

Questions:

1. Explain FH-SS?
2. Difference between FH-SS and DS-SS?
3. Explain Hop rate, Symbol Rate for FH-SS?
4. How to calculate Processing gain, jamming margin for FH-SS?
5.

Conclusion:

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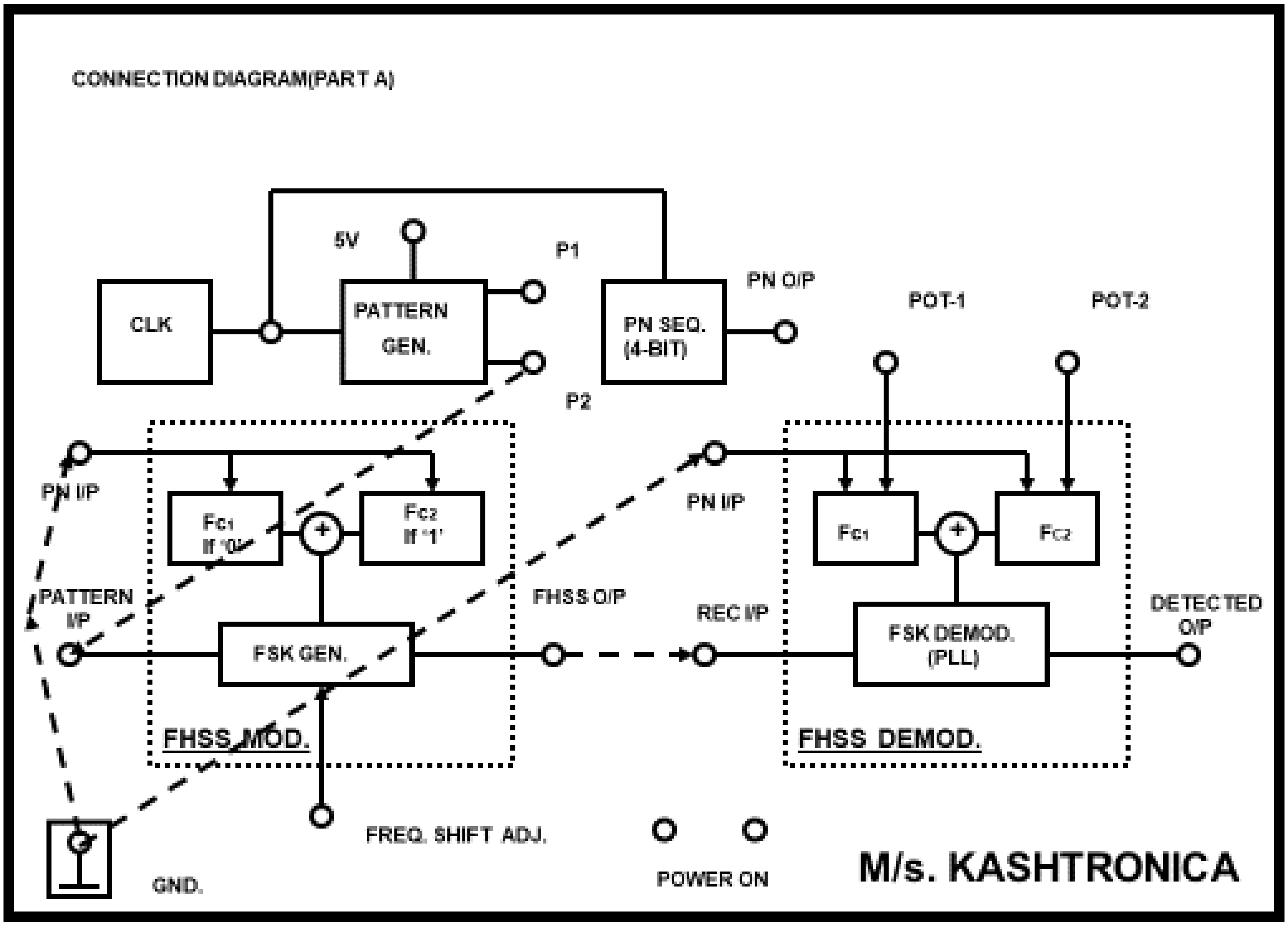
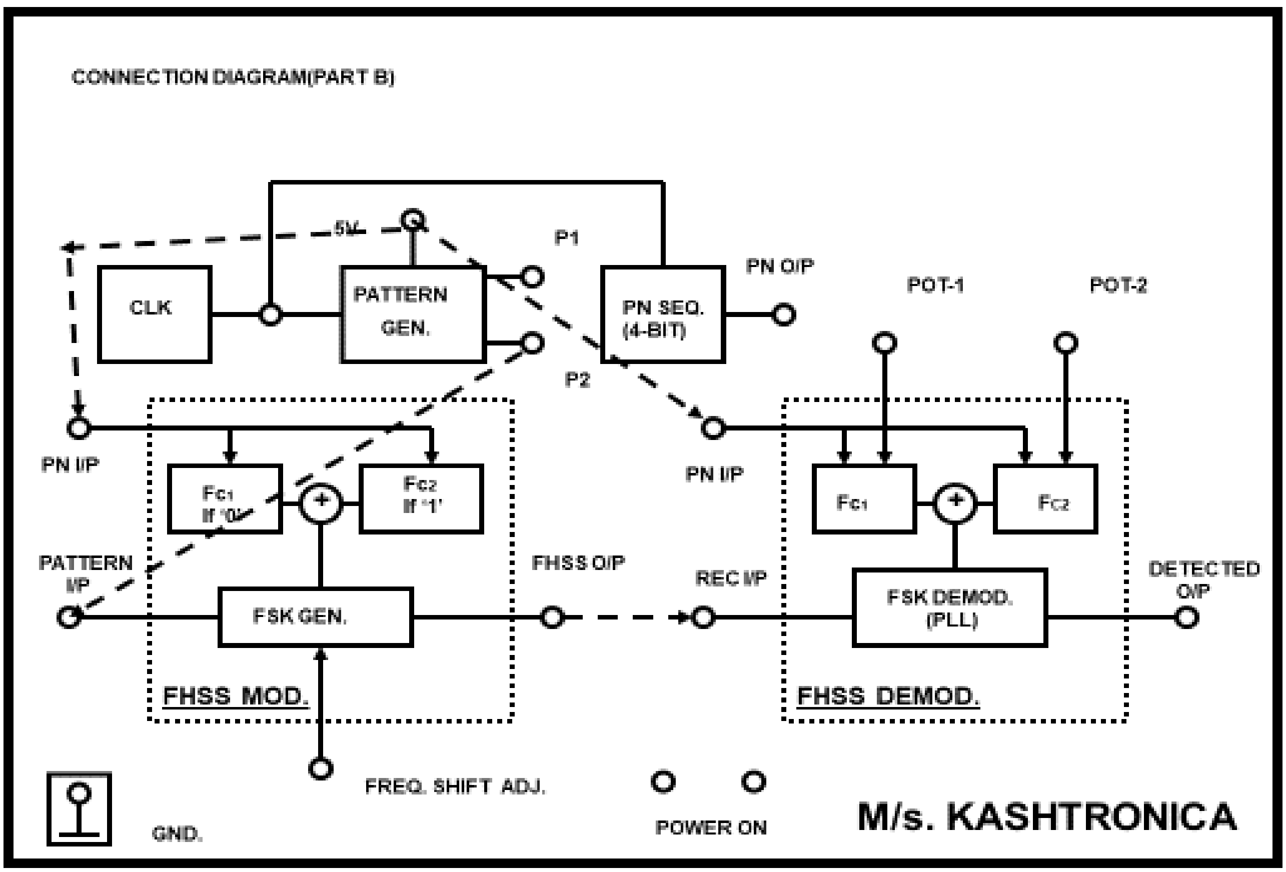
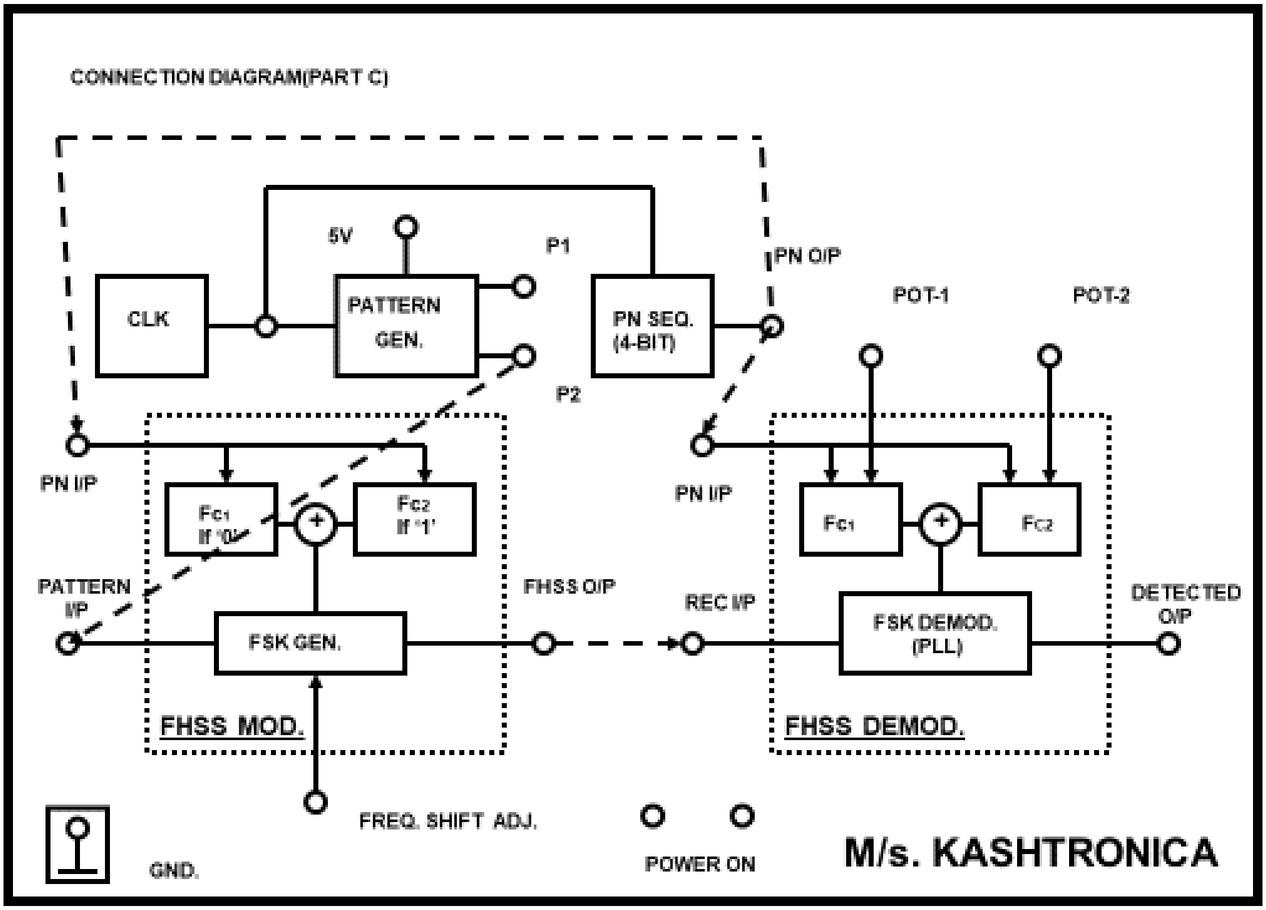
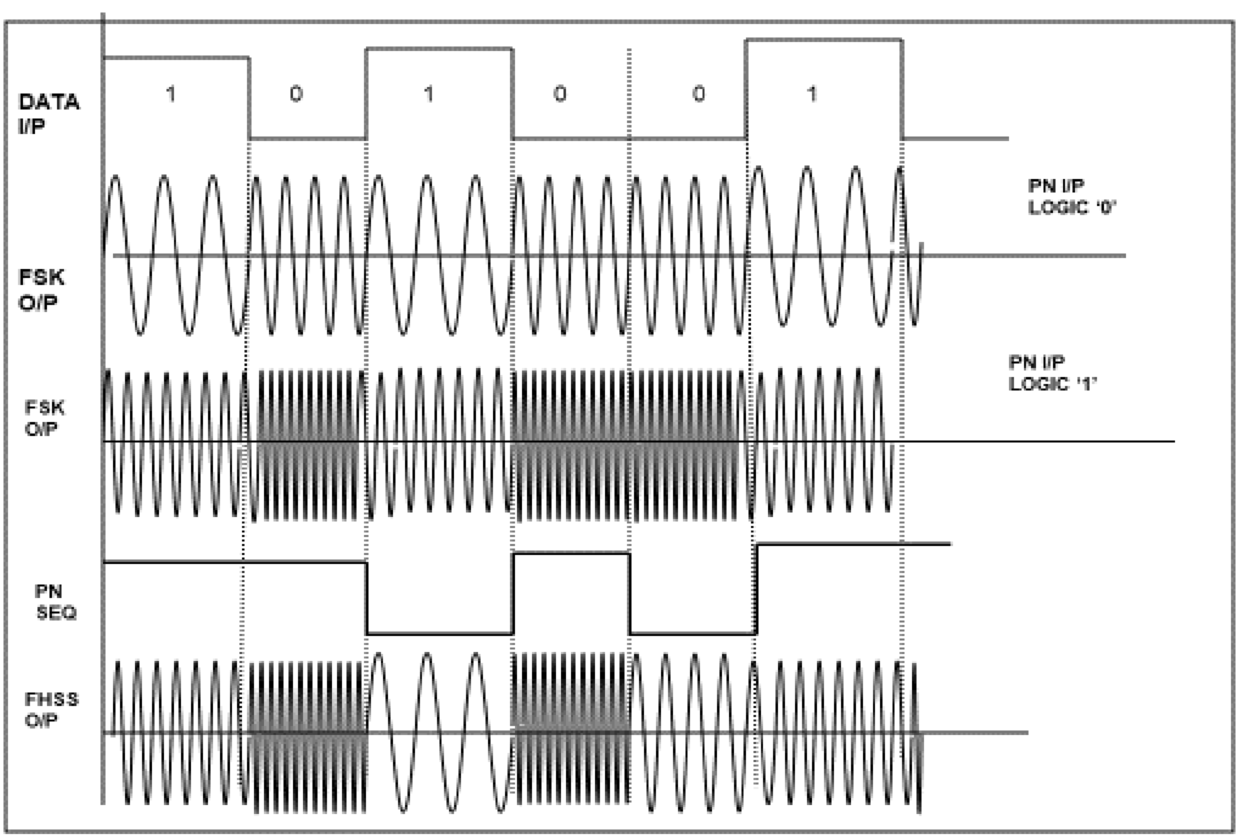
Timely submission (10)	Journal Presentation(10)	Performance(10)	Understanding(10)	Oral(10)	Total (50)
Sub Teacher Sign:					


CONNECTION DIAGRAM(PART A)
CLK
5V
PATTERN GEN.
P1
P2
PN SEQ. (4-BIT)
PN O/P
POT-1
POT-2
PN I/P
Fc1 If '0'
Fc2 If '1'
PATTERN I/P
FSK GEN.
FHSS O/P
PN I/P
REC I/P
Fc1
Fc2
FSK DEMOD. (PLL)
DETECTED O/P
FHSS MOD.
FHSS DEMOD.
FREQ. SHIFT ADJ.
GND.
POWER ON
M/s. KASHTRONICA


CONNECTION DIAGRAM(PART B)
CLK
5V
PATTERN GEN.
P1
P2
PN SEQ. (4-BIT)
PN O/P
POT-1
POT-2
PN I/P
Fc1 If '0'
Fc2 If '1'
PATTERN I/P
FSK GEN.
FHSS O/P
PN I/P
REC I/P
Fc1
Fc2
FSK DEMOD. (PLL)
DETECTED O/P
FHSS MOD.
FHSS DEMOD.
FREQ. SHIFT ADJ.
GND.
POWER ON
M/s. KASHTRONICA


CONNECTION DIAGRAM(PART C)
CLK
5V
PATTERN GEN.
P1
P2
PN SEQ. (4-BIT)
PN O/P
POT-1
POT-2
PN I/P
Fc1 If '0'
Fc2 If '1'
PATTERN I/P
FSK GEN.
FHSS O/P
REC I/P
Fc1
Fc2
FSK DEMOD. (PLL)
DETECTED O/P
FHSS MOD.
FHSS DEMOD.
FREQ. SHIFT ADJ.
GND.
POWER ON
M/s. KASHTRONICA


DATA I/P
1
0
1
0
0
1
FSK O/P
PN I/P LOGIC '0'
FSK O/P
PN I/P LOGIC '1'
PN SEQ
FHSS O/P