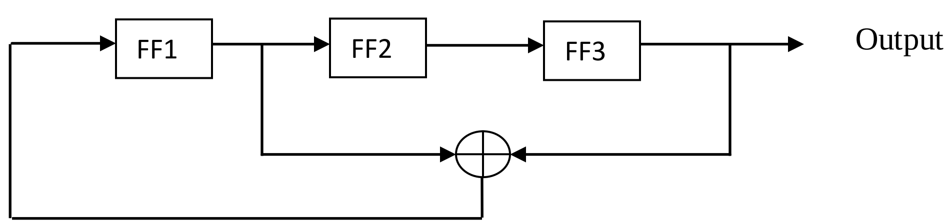
USN

INTERNAL ASSESSMENT TEST – III

Sub:	DIGITAL COMMUNICATION							Code:	15EC61
Date:	21/ 05/ 2018	Duration:	90 mins	Max Marks:	50	Sem:	VI	Branch:	ECE,TCE

Answer any 5 full questions

		Marks	CO	RBT
1	With the help of neat block diagrams of transmitter and receiver, explain coherent binary PSK modulation technique. Derive an expression for probability of error assuming equiprobable 0s and 1s.	[10]	CO3	L3
2	With the help of neat block diagrams of transmitter and receiver, explain coherent binary FSK modulation technique. Derive an expression for probability of error assuming equiprobable 0s and 1s.	[10]	CO3	L3
3	With the help of neat block diagrams of transmitter and receiver, explain QPSK modulation technique.	[10]	CO3	L2
4(a)	For the binary data 110010 sketch the waveform of the QPSK modulated signal. Clearly show the waveform of inphase and quadrature components of the modulated signal.	[06]	CO3	L2
4(b)	For the binary data 11010010, obtain the differentially encoded sequence. Indicate the phase of the DPSK modulated signal.	[04]	CO3	L2
5	Assuming the initial state of the shift register to be 100, find the output of the maximum length (ML) pseudo noise (PN) sequence generator shown in the following figure for 8 clock cycles.  Verify the properties of ML PN sequence considering one period of the output.	[10]	CO5	L2
6	With neat block diagrams of transmitter and receiver, explain direct sequence spread spectrum (DSSS) communication.	[10]	CO5	L2

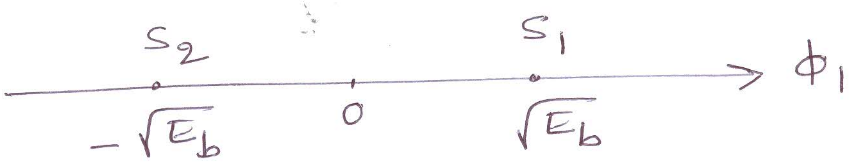
7	With neat block diagrams of transmitter and receiver, explain frequency hopped spread spectrum (FHSS) communication. Distinguish between slow frequency hopping and fast frequency hopping.	[10]	CO5	L2
8(a)	Write a note on application of direct sequence spread spectrum in code division multiple access (CDMA) communication systems.	[05]	CO5	L2
8(b)	Write a note on application of spread spectrum in wireless LANs.	[05]	CO5	L2

Solution and Scheme of Evaluation

1 $s_1(t) = \sqrt{\frac{2E_b}{T_b}} \cos(2\pi f_c t), \quad 0 \le t \le T_b$

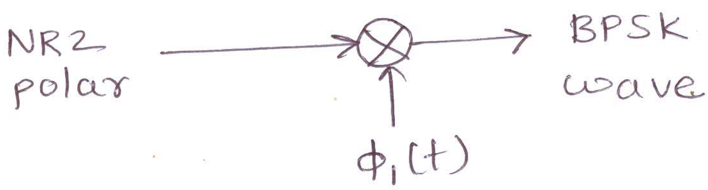
$s_2(t) = -\sqrt{\frac{2E_b}{T_b}} \cos(2\pi f_c t), \quad 0 \le t \le T_b$

$\phi_1(t) = \sqrt{\frac{2}{T_b}} \cos(2\pi f_c t), \quad 0 \le t \le T_b$



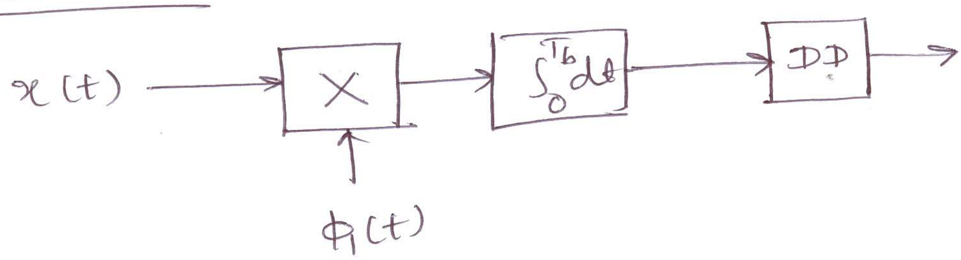
— (2)

Transmitter



— (2)

Receiver



— (2)

Probability of error — (4)

$$f_x(x/0) = \frac{1}{\sqrt{\pi N_0}} e^{-\frac{(x+\sqrt{E_b})^2}{N_0}}$$

$$P_e(0) = \int_0^{\infty} f_x(x/0)\, dx$$

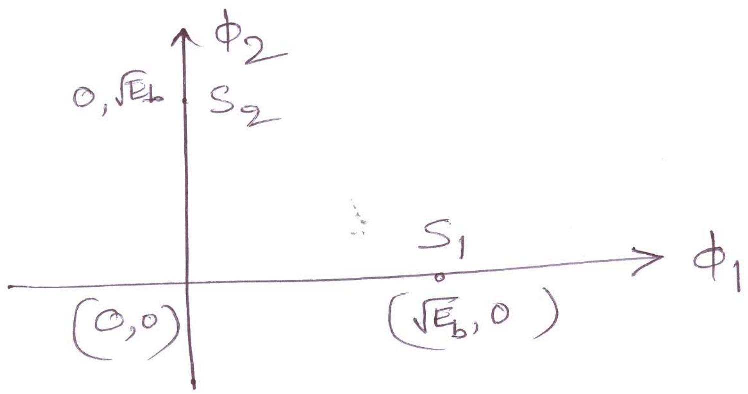
$$= Q\left(\sqrt{\frac{2E_b}{N_0}}\right)$$

2 $s_1(t) = \sqrt{\frac{2E_b}{T_b}} \cos(2\pi f_1 t), \quad 0 \le t \le T_b$

$s_2(t) = \sqrt{\frac{2E_b}{T_b}} \cos(2\pi f_2 t), \quad 0 \le t \le T_b$

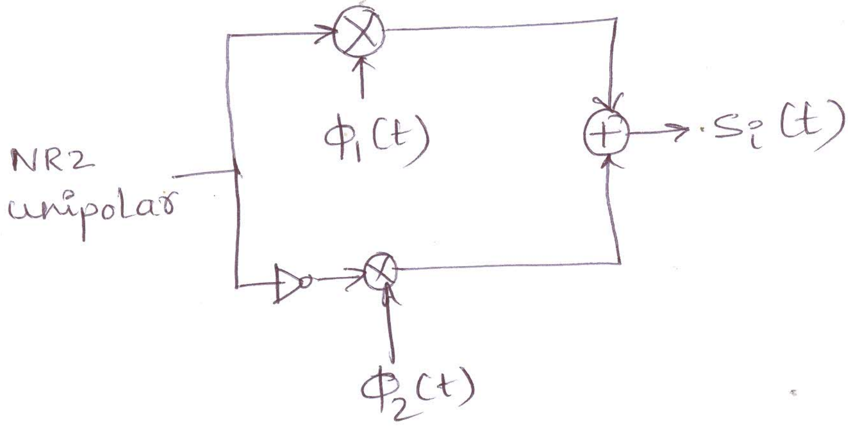
$\phi_1(t) = \sqrt{\frac{2}{T_b}} \cos(2\pi f_1 t), \quad 0 \le t \le T_b$

$\phi_2(t) = \sqrt{\frac{2}{T_b}} \cos(2\pi f_2 t), \quad 0 \le t \le T_b$



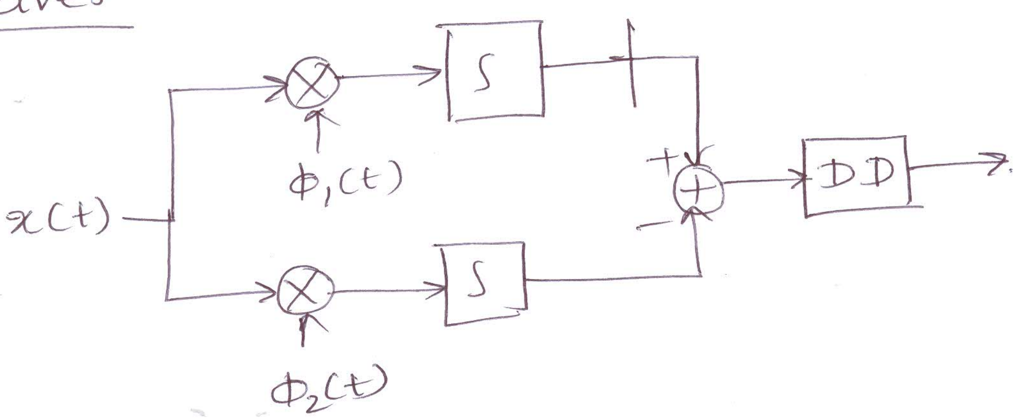
(2)

Transmitter



(2)

Receiver



(2)

Probability of error

$f_x(x/0) = \frac{1}{\sqrt{2\pi N_0}} e^{-\frac{(x-\sqrt{E_b})^2}{2N_0}}$ (4)

(3)

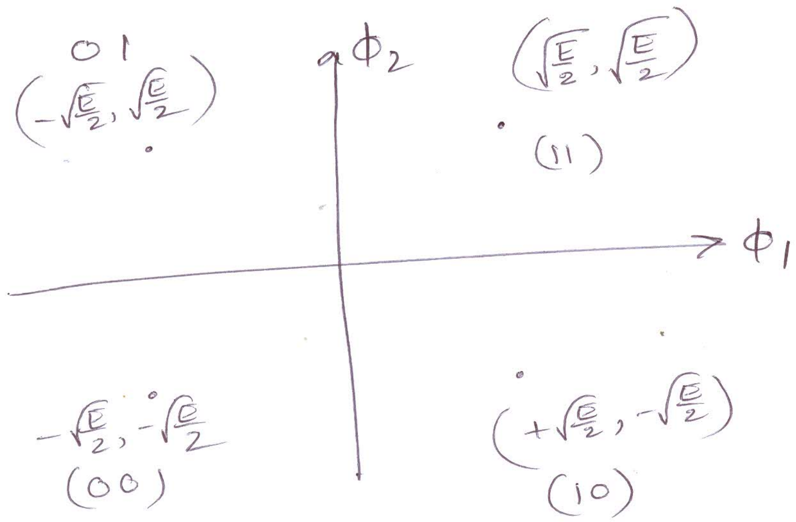
$$P_e(0) = \int_0^\infty f_x(x/0)\, dx$$

$$= Q\left(\sqrt{\frac{E_b}{N_0}}\right)$$

3. $s_i(t) = \sqrt{\frac{2E}{T}} \cos\left(2\pi f_c t + (2i-1)\frac{\pi}{4}\right), \quad 0 \le t \le T$

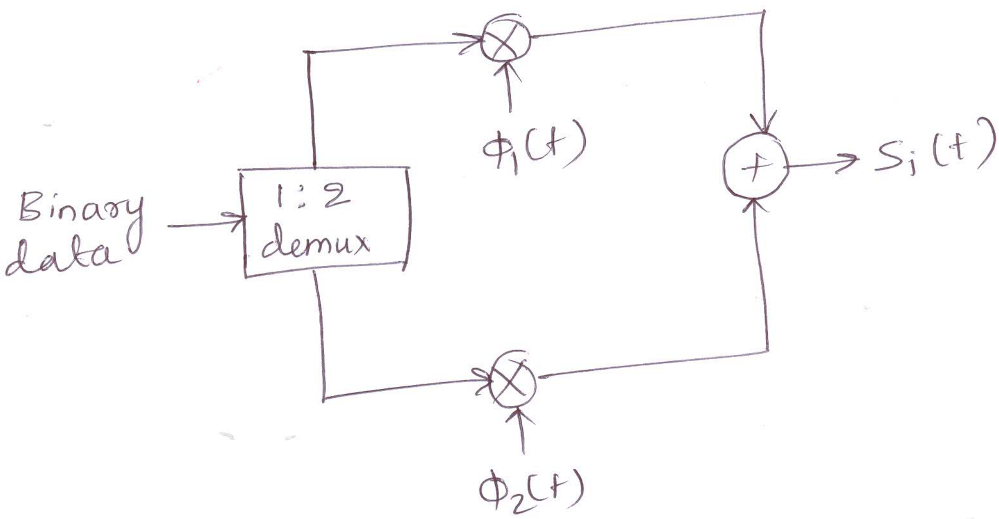
$\phi_1(t) = \sqrt{\frac{2}{T}} \cos(2\pi f_c t), \quad 0 \le t \le T$

$\phi_2(t) = \sqrt{\frac{2}{T}} \sin(2\pi f_c t), \quad 0 \le t \le T$



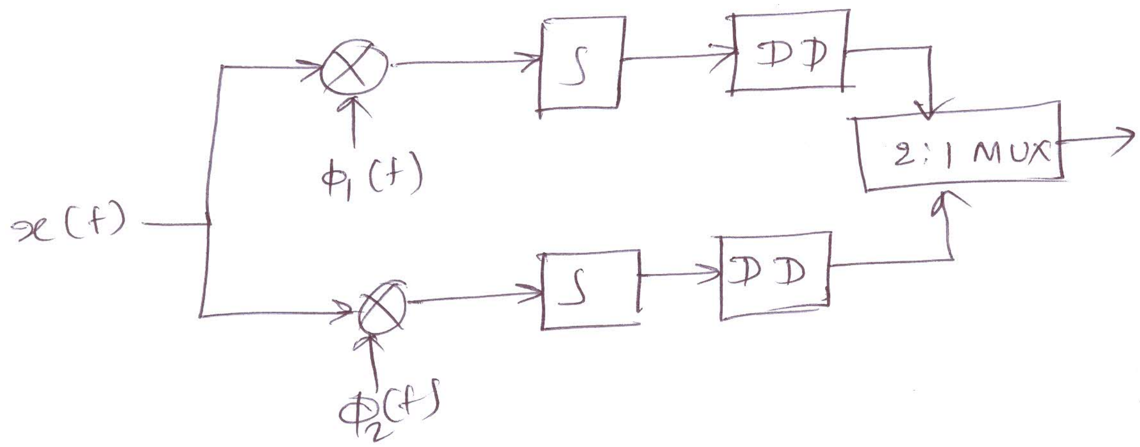
– (4)

Transmitter



(3)

Receiver



(3)

5

Clk	FF1	FF2	FF3
1	1	0	0
2	1	1	0
3	1	1	1
4	0	1	1
5	1	0	1
6	0	1	0
7	0	0	1
8	1	0	0

o/p :

0011101

(4)

i) Balance property

Number of 1s = 4

" " 0s = 3

(2)

ii) Run property

00, 111, 0, 1

Number of runs = $2^2 = 4$

(2)

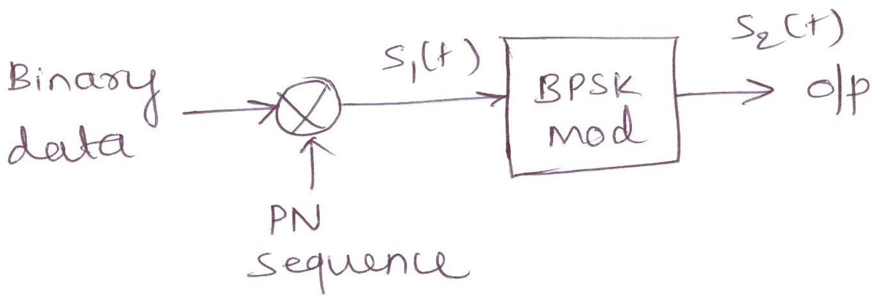
iii) Autocorrelation property

$$R_A(n) = \begin{cases} -1 & \text{for } n = lN \\ N & \text{for } n \neq lN \end{cases}$$

(2)

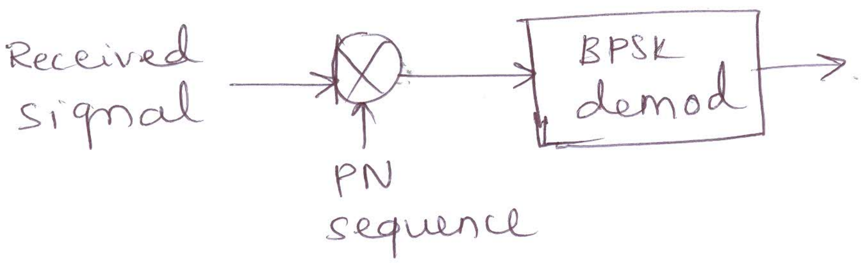
8

6 DSSS Transmitter



(3)

DSSS Receiver



(3)

$$s_1(t) = b(t)\, c_1(t)$$

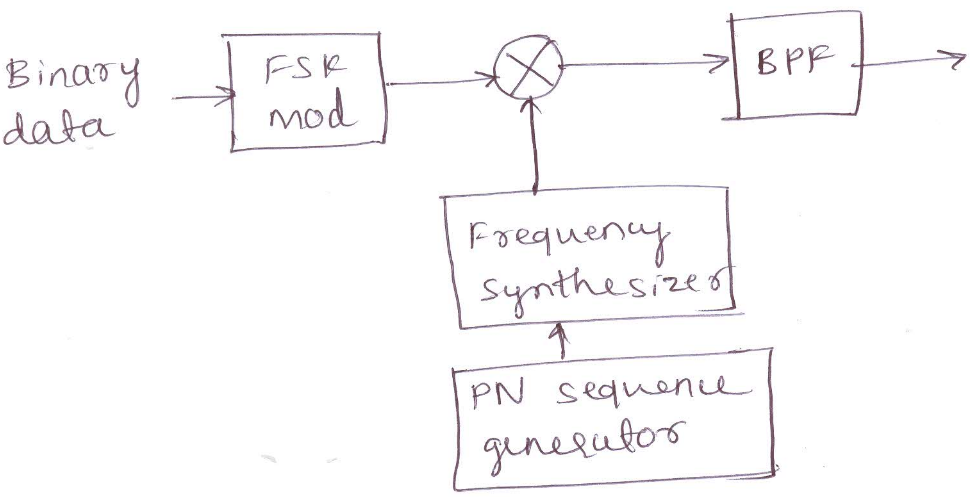
$$s_2(t) = s_1(t)\, c_2(t)$$

$$x(t) = s_i(t) + j(t)$$

$$x(t)\, c_1(t) = s_i(t) + j(t)\, c_2(t)$$

(4)

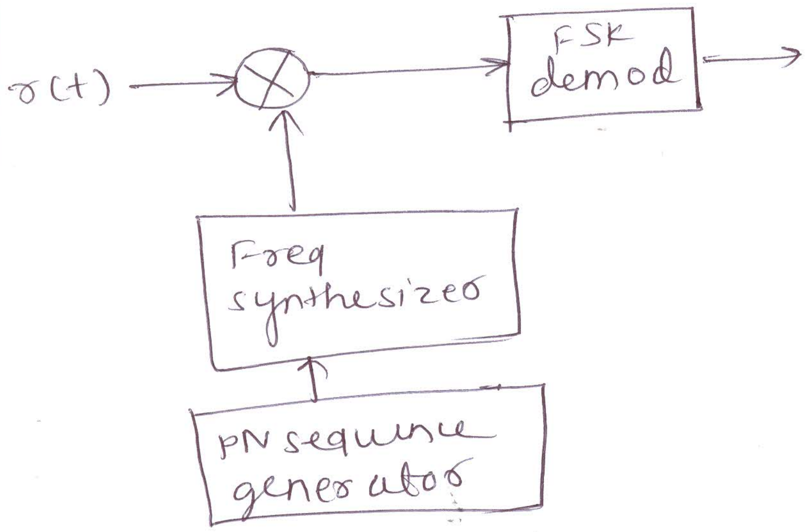
7. FHSS Transmitter



(5)

(6)

FHSS receiver



(5)

Slow frequency hopping

Symbol rate = integer × hop rate

Fast frequency hopping

Hop rate = integer × symbol rate

8a) In CDMA, each user is allotted a specific PN sequence which is used for DSSS modulation. PN sequence at transmitter and receiver must be synchronized. CDMA does not require an external synchronization clock. It also provides multipath rejection and resistance to jamming.

(5)

8b) Spread spectrum signals are used in wireless LAN standards IEEE 802.11 and 802.11b which operate in ~~2.4~~ 2.4 GHz.

In 802.11, 11-chip Barker sequence is used for modulation and demodulation along with BPSK modulation.

(7)

(5)