SOLUTIONS – am group

1) A sine wave is to be used for two different signalling schemes: i) PSK; and ii) QPSK. The duration of a signal element is 10^{-5} s. If the received signal is of the following form,

$s(t) = 0.005\sin(2\pi 10^6 t + \theta)$ volts and if the measured noise power at the receiver is 2.5×10^{-8} watts, determine E_b/N_0 in dB for each case.

[8 marks]

Answer:

T_s = signal element period; T_b = bit period; A = amplitude = 0.005

i) $T_s = T_b = 10^{-5}$ sec

$$P = \frac{1}{T_s}\int_0^{T_s} s^2(t) = \frac{A^2}{2}$$

[2 marks]

$$E_b = P\times T_b = P\times T_s = \frac{A^2}{2}\times T_s;\ N_0 = 2.5\times10^{-8}\times T_s$$

$$\frac{E_b}{N_0} = \frac{(A^2/2)\times T_s}{2.5\times10^{-8}\times T_s} = 500;\ (E_b/N_0)_{dB} = 10\log 500 = 27\text{dB}$$

[2 marks]

ii)

$$T_b = \frac{T_s}{2};\ E_b = P\times\frac{T_s}{2};\ N_0 = 2.5\times10^{-8}\times T_s$$

[2 marks]

$$(E_b/N_0) = 250;\ (E_b/N_0)_{dB} = 10\log 250 = 24\text{dB}$$

[2 marks]

2) The following table illustrates the operation of an FHSS system for one complete period of the PN sequence.

3)

Time	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Input data	0	1	1	1	1	1	1	0	0	0	1	0	0	1	1	1	1	0	1	0
Frequency	f_1		f_3		f_{27}		f_{26}		f_8		f_{10}		f_1		f_3		f_2		f_2	
PN Sequence	001				110				011				001				001			

4) To determine:

i) What is the period of the PN sequence?

ii) The system makes use of a form of FSK. What form of FSK is it?

iii) What is the number of bits per symbol?

iv) What is the number of FSK frequencies?

v) What is the length of a PN sequence per hop?

vi) Is this a slow or fast FH system?

vii) What is the total number of possible hops?

viii) Show the variation of the dehopped frequency with time.

[8 marks]

Answer:

i) Period of the PN sequence is 15 **[1 Mark]**
ii) MFSK **[1 Mark]**
iii) $L = 2$ **[1 Mark]**
iv) $M = 2^L = 4$ **[1 Mark]**
v) $k = 3$ **[1 Mark]**
vi) slow FHSS **[1 Mark]**
vii) $2^k = 8$ **[1 Mark]**
viii) **[1 Mark]**

Time	0	1	2	3	4	5	6	7	8	9	10	11
Input data	0	1	1	1	1	1	1	0	0	0	1	0
Frequency	f_1		f_3		f_3		f_2		f_0		f_2	

Time	12	13	14	15	16	17	18	19
Input data	0	1	1	1	1	0	1	0
Frequency	f_1		f_3		f_2		f_2	