SOLUTIONS – pm group

1) Derive the spectrum efficiency equations based E_b/N_0 and Shannon capacity.

[8 marks]

Answer:

$\frac{E_b}{N_0} = \frac{S}{N_0 \cdot R}$ 2 marks, $N = N_0 B_T$ 1 mark, S/N, SNR

$\Downarrow$

$\frac{E_b}{N_0} = \frac{S \cdot B_T}{N \cdot R}$ 1 mark,

$C = B \cdot \log_2(1 + SNR)$ bits/s

$\Downarrow$

$SNR = 2^{C/B} - 1$, $B = B_T$, $R \triangleq C$

2 marks

$\frac{E_b}{N_0} = \frac{B}{C}(2^{C/B} - 1)$ 2 marks

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

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_{21}	f_{11}	f_3	f_3	f_3	f_{22}	f_{10}	f_0	f_0	f_1	f_{22}	f_9	f_1	f_3	f_3	f_{22}	f_{11}	f_3	f_3
PN Sequence	001	110	011	001	001	001	110	011	001	001	001	110	011	001	001	001	110	011	001	001

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) fast 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	