8 Ocak 2023 Pazar 00:55

Q1:

What is the receiver input noise power level if temperature is T=35 ºC and bandwidth is B=37 MHz as dBm ?

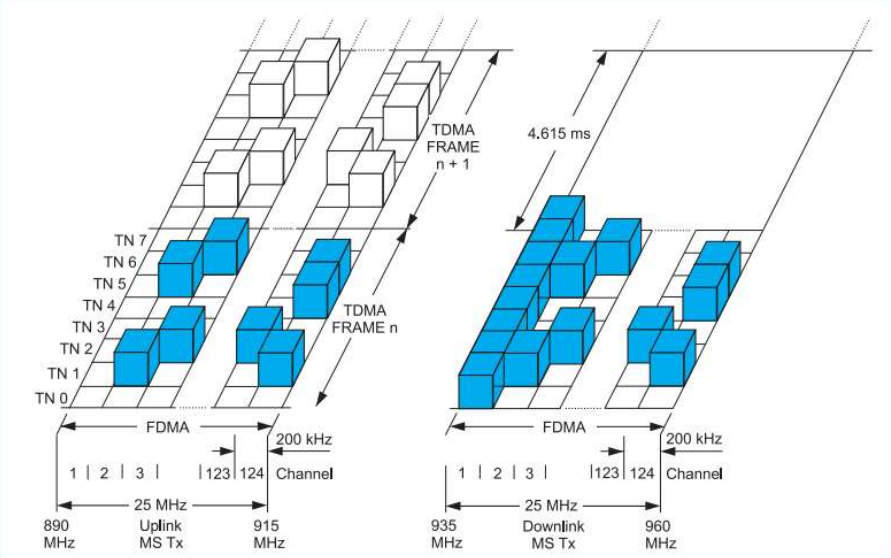
Tolerance ± 0.5dB nominal

$$-228.6 + 10\log\ (273 + 35) + 10\log\left(37 \cdot 10^{6}\right) \quad = -128.0324756$$

-128.03dB >> -98.03 dBm

Q2:

2G Communication schema is given as



and each user could only use one time slot in a frame. If communication use QPSK modulation what is the maximum total downloaded bytes in 4 second as kB?

Tolerance ± 0.05 relative

$$R = B \cdot \frac{\left(\frac{\log M}{\log 2}\right)}{1 + r}$$

For QPSK >> M = 4 || B = 200 kHz

$$R = \ 200\frac{\left(\frac{\log 4}{\log 2}\right)}{1} \qquad = 400$$

R= 400 kbps
4 sec | 8 user

$$\frac{(400 \cdot 4)}{8} \quad =200$$

200kb = 25kB

Q3:

In a communication system, the signal power is 27 mW and the noise power is 17 µW over 31 MHz bandwidth, What is the channel capacity as Mbps?

Tolerance ± 0.05 relative

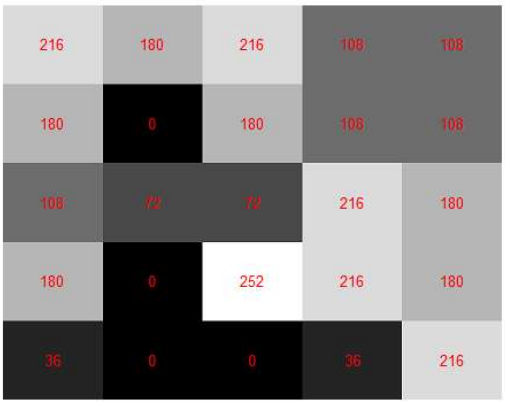
C= B*log2(1+ S/N)

$$31 \cdot 10^6 \cdot \frac{\left(\log\left(1 + \frac{(27 \cdot 10^{-3})}{17 \cdot 10^{-6}}\right)\right)}{\log 2} = 329657627.7$$

329657627 bps = 329.657 Mbps

Q4: Shannon Entropy

5x5 sized 8 bits gray (single channel) image levels are shown in figure



Calculate the required minimum bits for image (or matrix) ?

Tolerance ±2bits nominal

$$H = -\sum_{i=1}^{k} p_i \log_2(p_i)$$

$$-\left(\frac{1}{25}\left(\frac{\log\left(\frac{1}{25}\right)}{\log 2}\right)+2 \cdot \frac{2}{25}\left(\frac{\log\left(\frac{2}{25}\right)}{\log 2}\right)+\frac{4}{25}\left(\frac{\log\left(\frac{4}{25}\right)}{\log 2}\right)+2 \cdot \frac{5}{25}\left(\frac{\log\left(\frac{5}{25}\right)}{\log 2}\right)+\frac{6}{25}\left(\frac{\log\left(\frac{6}{25}\right)}{\log 2}\right)\right) = 2.614693952$$

$$2.614693952 \cdot 25 = 65.3673488$$

Q5:

Consider sending real-time voice from A to B over a packet-switched network. A converts analog voice to a digital 34 kbs bit stream then groups the bits into 45-byte packets. There is one link between A and B, its transmission rate is 3.8 Mbps and its propagation delay is 10 msec.

As soon as B receives an **entire packet**. It converts the packet's bit to an analog signal (ignore the DAC delay).

How much time elapses (communication delay) from the time a bit is created (from the original analog signal at A) until the bit is decoded (as part of the analog signal at B) as msec?

Tolerance ±0.05 relative

34 kbps bit stream 45-byte packages
Prop delay 10ms trans rate 3.8 Mbps

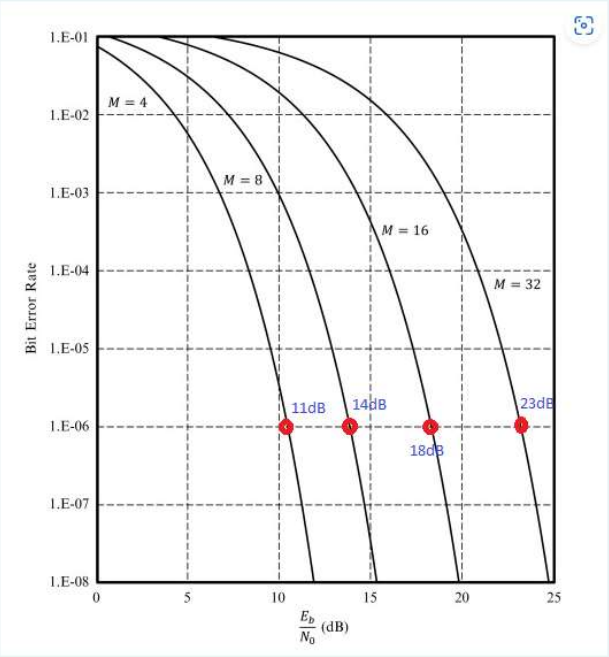
$$\frac{(45 \cdot 8)}{34 \cdot 10^3} \cdot 10^3 = 10.58823529$$

$$\frac{(45 \cdot 8)}{3.8 \cdot 10^6} \cdot 10^3 = 0.09473684211$$

$$10 + \frac{(45 \cdot 8)}{34 \cdot 10^3} \cdot 10^3 + \frac{(45 \cdot 8)}{3.8 \cdot 10^6} \cdot 10^3 = 20.68297214$$

Q6:

BER performance of M-PSK modulation is given in figure and 10^{-6} values highlighted



What is the minimum required SNR values (not dB) for 16 -PSK modulation @ BER=10^{-6} value ?

Tolerance ± 0.05 relative

From Graph

$$\frac{Eb}{N_0} = 18dB$$

$$10^{1.8} = 63.095734$$

$$\frac{Rb}{B} = \frac{\left(\frac{\log M}{\log 2}\right)}{1+a} = 4$$

$$63.095734 \cdot 4 = 252.382$$

Q7:

A cable parameters given below

Technical Parameters

Frequency (MHz)	Attenuation (min) (dB/100m)	NEXT (min) (dB)
1	2.0	75.3
4	3.8	66.3
8	5.4	61.8
10	6.0	60.3
16	7.6	57.3
20	8.5	55.8
25	9.6	54.3
31.3	10.7	52.9
62.5	15.5	48.4
100	19.9	45.3
150	25.3	42.5
200	29.2	40.8
250	33.0	39.3
300	36.6	38.2
350	44.8	37.1
400	46.2	36.3
550	52.2	34.2

What is the maximum communication range for 200 MHz frequency as meter ?

Tolerance ± 0.05 relative

At 200 kHz

$$\frac{40.8}{29.2} \cdot 100 = 139.726$$

Q8:

If the wireless link is operated 600MHz and both side antennas are the same with G=6dBi gains in free-space. What is the maximum received power level [dBm] when distance is 400m and transmitted power is equal to 1W.

Tolerance ±1 Nominal and use dot "." for decimal

$$Prx = Ptx + Grx + Gtx - Pl$$

$$Pl = 20 \log\left(\frac{(4\pi d)}{\lambda}\right) \text{ and } \lambda = \frac{c}{f}$$

$$20 \log\left(\frac{4 \cdot \pi \cdot 400}{\frac{(3 \cdot 10^8)}{600 \cdot 10^6}}\right) = 80.0459$$

$$30 + 6 + 6 - 80.046 = -38.046$$

Q9:

Eb/No [dB]	BPSK	QPSK	8PSK	16PSK	32PSK	64PSK
5	5.95E-03	5.95E-03	3.19E-02	8.29E-02	1.37E-01	1.89E-01
6	2.39E-03	2.39E-03	2.05E-02	6.82E-02	1.21E-01	1.75E-01
7	7.73E-04	7.73E-04	1.20E-02	5.43E-02	1.06E-01	1.60E-01
8	1.91E-04	1.91E-04	6.18E-03	4.15E-02	9.15E-02	1.45E-01
9	3.36E-05	3.36E-05	2.75E-03	3.00E-02	7.84E-02	1.31E-01
10	3.87E-06	3.87E-06	1.01E-03	2.02E-02	6.61E-02	1.16E-01
11	2.61E-07	2.61E-07	2.94E-04	1.26E-02	5.45E-02	1.03E-01
12	9.01E-09	9.01E-09	6.34E-05	7.01E-03	4.35E-02	9.03E-02
13	1.33E-10	1.33E-10	9.42E-06	3.43E-03	3.32E-02	7.85E-02
14	6.81E-13	6.81E-13	8.76E-07	1.42E-03	2.41E-02	6.75E-02
15	9.12E-16	9.12E-16	4.52E-08	4.79E-04	1.63E-02	5.72E-02
16	2.27E-19	2.27E-19	1.11E-09	1.25E-04	1.01E-02	4.75E-02
17	6.76E-24	6.76E-24	1.07E-11	2.34E-05	5.64E-03	3.82E-02
18	1.40E-29	1.40E-29	3.21E-14	2.93E-06	2.76E-03	2.95E-02
19	1.00E-36	1.00E-36	2.19E-17	2.19E-07	1.15E-03	2.16E-02
20	0.00E+00	0.00E+00	2.33E-21	8.57E-09	3.88E-04	1.49E-02
21	0.00E+00	0.00E+00	2.39E-26	1.49E-10	1.01E-04	9.42E-03
22	0.00E+00	0.00E+00	1.29E-32	9.35E-13	1.91E-05	5.39E-03
23	0.00E+00	0.00E+00	0.00E+00	1.62E-15	2.39E-06	2.73E-03
24	0.00E+00	0.00E+00	0.00E+00	5.55E-19	1.80E-07	1.18E-03
25	0.00E+00	0.00E+00	0.00E+00	2.49E-23	7.10E-09	4.18E-04
26	0.00E+00	0.00E+00	0.00E+00	8.57E-29	1.25E-10	1.16E-04
27	0.00E+00	0.00E+00	0.00E+00	1.17E-35	7.89E-13	2.36E-05
28	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E-15	3.26E-06
29	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.84E-19	2.77E-07
30	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.21E-23	1.28E-08
31	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.84E-29	2.72E-10
32	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-35	2.19E-12
33	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.23E-15
34	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.68E-18
35	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.99E-22

BER performance of the MPSK modulation is given in table.

If the channel filter parameter r=0.1 and BER is required $1E^{-6}$ what is the minimum SNR ratio [dB] for 32PSK modulation?

Use integer Eb/No and do not interpolate.

Tolerance ±0.5 nominal

$$\frac{Eb}{N_0} = 24\ dB$$

$$24dB = 10^{2.4}$$

$$\frac{R_0}{B} = \frac{\left(\frac{\log M}{\log 2}\right)}{1+r} = \frac{\left(\frac{\log 32}{\log 2}\right)}{1+0.1} = 4.545$$

$$\frac{Eb}{N_0} \cdot \frac{R_0}{B} = \frac{S}{N}$$

$$10^{2.4} \cdot 4.545 = 1141.65$$

$$10\ \log\ (1141.65) = 30.5753$$

Q10:

The original message was first organized 7 bits rows and even party bit added each row. Then column even parity added to last row.

The below is the nine bytes that the receiver collect.

01100101 10110100 00011000 01000111 01000010 10101001 11011000 11001010 01110111

Decode the message data and find the characters by using ascii table.

0	1	1	0	0	1	0	1
1	0	1	1	0	1	0	0
0	0	0	1	1	0	0	0
0	1	0	0	0	1	1	1
0	1	0	0	0	0	1	0

1	0	1	0	1	0	0	1
1	1	0	1	1	0	0	0
1	1	0	0	1	0	1	0
0	1	1	1	0	1	1	1

01100101 = e
01101000 = h
01100010 = b
00110100 = 4
00110101 = 5
00110110 = 6
01100101 = e

EHB456E