



Faculty of Engineering and Technology
Department of Electrical and Computer Engineering
Wireless and Mobile Networks, ENCS5323
Project – Online Calculator for Wireless and Mobile Networks

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Design and build an online calculator:

First Question:

The number of bits and rate of the sampler, quantizer, source encoder, channel encoder, and interleaver:

After making the user enter the inputs then click calculate the outputs will show based on these equations:

Sampling Frequency = $2 \times \text{bandwidth}$

Quantization Levels = $2^{\text{number of bits}}$

Input source Encoder = sampling frequency \times number of bits

Source Encoder Rate = sampling frequency \times number of bits \times compression rate

Channel Encoder Rate = $\frac{\text{Source Encoder Rate}}{\text{Encoder Rate}}$

Interleaver Rate = Channel Encoder Rate

First scenario:

The screenshot shows a web browser window with a URL of 127.0.0.1:5000. The page is titled "Sampler, Quantizer, Source Encoder, Channel Encoder, and Interleaver Calculator". On the left, there is a sidebar with a calculator icon and five buttons: "Sampler and Quantizer Calculator" (highlighted in pink), "Resource Elements Calculator", "Power Transmission Calculator", "Multiple Access Throughput Calculator", and "Cellular System Design Calculator". Below these buttons, the names "Mariam Hamad - 1200837" and "Leena Affouri - 1200335" are listed. The main area is divided into three columns. The first column, labeled "Inputs:", contains five input fields: "Bandwidth:" (value 4, with a unit selector for Hertz (Hz) and Kilohertz (kHz)), "Number of Quantization Bits:" (value 8), "Compression rate (R2):" (value 0.25), "Channel Encoder rate (Rc):" (value 0.5), and "Number of Interleaver Bits:" (value 1024). A pink "Calculate" button is at the bottom of this column. The second column, labeled "Results:", contains five output fields: "Sampling Frequency:" (value 8000 samples/sec), "Quantization Levels:" (value 256 Levels), "Input Source Encoder bit rate:" (value 64000 bits/sec), "Output Source Encoder bit rate:" (value 16000.0 bits/sec), and "Output Channel Encoder bit rate:" (value 32000.0 bits/sec). The last field, "Interleaver bit rate:", also shows a value of 32000.0 bits/sec.

Figure 1: First question first scenario

Second scenario:

Sampler, Quantizer, Source Encoder, Channel Encoder, and Interleaver Calculator

Calculator icon

Navigation buttons:

- Sampler and Quantizer Calculator
- Resource Elements Calculator
- Power Transmission Calculator
- Multiple Access Throughput Calculator
- Cellular System Design Calculator

Authors: Mariam Hamad - 1200837, Leena Affouli - 1200335

Inputs:

Bandwidth: Hertz (Hz) / KiloHertz (kHz)

Number of Quantization Bits:

Compression rate (R_s):

Channel Encoder rate (R_c):

Number of Interleaver Bits:

Results:

Sampling Frequency:

Quantization Levels:

Input Source Encoder bit rate:

Output Source Encoder bit rate:

Output Channel Encoder bit rate:

Interleaver bit rate:

Figure 2: First question second scenario

Third scenario:

Sampler, Quantizer, Source Encoder, Channel Encoder, and Interleaver Calculator

Calculator

Sampler and Quantizer Calculator

Resource Elements Calculator

Power Transmission Calculator

Multiple Access Throughput Calculator

Cellular System Design Calculator

Mariam Hamad - 1200837

Leena Affouri - 1200335

Inputs:

Bandwidth:

6

Hertz (Hz) Kilohertz (kHz)

Number of Quantization Bits:

5

Compression rate (R_s):

0.28

Channel Encoder rate (R_c):

0.5

Number of Interleaver Bits:

1024

Calculate

Results:

Sampling Frequency:

12000 samples/sec

Quantization Levels:

32 Levels

Input Source Encoder bit rate:

60000 bits/sec

Output Source Encoder bit rate:

16800.0 bits/sec

Output Channel Encoder bit rate:

33600.0 bits/sec

Interleaver bit rate:

33600.0 bits/sec

Figure 3: First question third scenario

Second question:

The number of bits and rate for resource elements, OFDM symbol, Resource Blocks, and maximum transmission using parallel resource blocks:

After making the user enter the inputs then click calculate the outputs will show based on these equations:

$$\text{Subcarriers} = \frac{\text{bandwidth}}{\text{spacing}}$$

$$\text{bits Per Resource Element} = \log_2 \text{ modulation Val}$$

$$\text{bits Per OFDM Symbol} = \text{bits Per Resource Element} \times \text{subcarriers}$$

$$\text{bits Per OFDM Resource Block} = \text{bits Per OFDM Symbol} \times \text{OFDM Symbols}$$

$$\text{transmission Rate} = \frac{(\text{number Of Parallel Rb} \times \text{bits Per OFDM Resource Block})}{(\text{resource Block Duration} \times 10^{-3})}$$

First scenario:

Resource Elements, OFDM, and Resource Blocks Calculator

Inputs:

Bandwidth: 180000 Hz

Subcarrier Spacing: 15000 Hz

Number Of OFDM Symbols: 7

Resource Block Duration: 0.0005 sec

Modulation Level (QAM): 1024

Number of Parallel Resource Blocks: 4

Calculate

Results:

Bits per Resource Element: 10.00 bits

Bits per OFDM Symbol: 120.00 bits

Bits per OFDM Resource Block: 840.00 bits

Transmission Rate (bps): 6720000.00 bps

Sampler and Quantizer Calculator

Resource Elements Calculator

Power Transmission Calculator

Multiple Access Throughput Calculator

Cellular System Design Calculator

Mariam Hamad - 1200837

Leena Affouri - 1200335

Figure 4: Second question First scenario

Second scenario:

Resource Elements, OFDM, and Resource Blocks Calculator

Sampler and Quantizer Calculator
Resource Elements Calculator
Power Transmission Calculator
Multiple Access Throughput Calculator
Cellular System Design Calculator

Mariam Hamad - 1200837
Leena Affawi - 1200335

Inputs:

Bandwidth: 180 kHz

Subcarrier Spacing: 15 kHz

Number Of OFDM Symbols: 7

Resource Block Duration: 0.5 ms

Modulation Level (QAM): 1024

Number of Parallel Resource Blocks: 4

Calculate

Results:

Bits per Resource Element: 10.00 bits

Bits per OFDM Symbol: 120.00 bits

Bits per OFDM Resource Block: 840.00 bits

Transmission Rate (bps): 6720000.00 bps

Figure 5: Second question second scenario

Third scenario:

Resource Elements, OFDM, and Resource Blocks Calculator

Samplers and Quantizer Calculator
Resource Elements Calculator
Power Transmission Calculator
Multiple Access Throughput Calculator
Cellular System Design Calculator

Mariam Hamad - 1200837
Leena Affouri - 1200335

Inputs:

Bandwidth: 150 kHz

Subcarrier Spacing: 15 kHz

Number Of OFDM Symbols: 7

Resource Block Duration: 0.5 msec

Modulation Level (QAM): 64

Number of Parallel Resource Blocks: 4

Results:

Bits per Resource Element: 6.00 bits

Bits per OFDM Symbol: 60.00 bits

Bits per OFDM Resource Block: 420.00 bits

Transmission Rate (bps): 3360.00 bps

Calculate

Figure 6: Second question third scenario

Third question:

Power transmitted in a flat environment based on the transmitter and receiver specifications:

After making the user enter the inputs then click calculate the outputs will show based on these equations:

$$pr = \text{link margin} + k + \text{noise temp} + \text{noise figure} + \text{data rate} + \text{results['EbN0']}$$

$$pt = pr + \text{path loss} + \text{antenna feed line loss} + \text{other losses} + \text{fade margin} - \text{transmit antenna gain} - \text{receive antenna gain} - \text{receiver amplifier gain}$$

First scenario:

Power Transmitted in a Flat Environment

Inputs:

- Path Loss:
- Frequency:
- Transmit Antenna Gain:
- Receive Antenna Gain:
- Data Rate (bps):
- Antenna Feed Line Loss:
- Other Losses:

Results:

- E_b/N_0 (dB):
- P_r (dB):
- P_t (dB):
- P_r (No Unit):
- P_t (No Unit):
- P_r (dBm):
- P_t (dBm):


Additional Parameters:

- Fade Margin:
- Receiver Amplifier Gain:
- Noise Figure:
- Noise Temperature (K):
- Link Margin:
- Modulation: ☐ BPSK/QPSK ☐ BPSK ☐ 16PSK
- Bit Error Rate (BER):

Figure 7: Third question first scenario

Second scenario:

Power Transmitted in a Flat Environment



- Sampler and Quantizer Calculator
- Resource Elements Calculator
- Power Transmission Calculator**
- Multiple Access Throughput Calculator
- Cellular System Design Calculator

Inputs:

Path Loss : ☐ dB ☒ dSm ☐ no Unit

Frequency: ☒ Hz ☐ kHz ☐ MHz

Transmit Antenna Gain : ☐ dB ☒ dSm ☐ no Unit

Receive Antenna Gain : ☐ dB ☒ dSm ☐ no Unit

Data Rate (bps):

Antenna Feed Line Loss : ☐ dB ☒ dSm ☐ no Unit

Other Losses : ☐ dB ☒ dSm ☐ no Unit

Results:

E_b/N_0 (dB):

P_r (dB):


P_t (dB):

P_r (No Unit):

P_t (No Unit):

P_r (dSm):

P_t (dSm):



Inputs:

Fade Margin : ☐ dB ☒ dSm ☐ no Unit

Receiver Amplifier Gain : ☐ dB ☒ dSm ☐ no Unit

Noise Figure : ☐ dB ☒ dSm ☐ no Unit

Noise Temperature (K):

Link Margin : ☐ dB ☒ dSm ☐ no Unit

Modulation:

☒ BPSK ☐ QPSK ☐ 8PSK ☐ 16PSK

Bit Error Rate (BER):

☐ ☐ ☒ ☐ ☐ ☐ ☐ ☐

10^{-2} 10^{-3} 10^{-4} 10^{-5} 10^{-6} 10^{-7} 10^{-8}

Calculate





Figure 8: Third question second scenario

Third scenario:

Power Transmitted in a Flat Environment



Sampler and Quantizer Calculator

Resource Elements Calculator

Power Transmission Calculator

Multiple Access Throughput Calculator

Cellular System Design Calculator

Mariam Hamad - 1200837

Leena Affouli - 1200335

Inputs:

Path Loss : ☐ dB ☒ dBm ☐ No Unit

Frequency: ☐ Hz ☒ kHz ☐ MHz

Transmit Antenna Gain : ☐ dB ☒ dBm ☐ No Unit

Receive Antenna Gain : ☐ dB ☒ dBm ☐ No Unit

Data Rate (bps):

Antenna Feed Line Loss : ☐ dB ☒ dBm ☐ No Unit

Other Losses : ☐ dB ☒ dBm ☐ No Unit

Results:

E_b/N_0 (dB):

P_r (dB):


P_t (dB):

P_r (No Unit):

P_t (No Unit):

P_r (dBm):

P_t (dBm):



Inputs:

Fade Margin : ☐ dB ☒ dBm ☐ No Unit

Receiver Amplifier Gain : ☐ dB ☒ dBm ☐ No Unit

Noise Figure : ☐ dB ☒ dBm ☐ No Unit

Noise Temperature (K):

Link Margin : ☐ dB ☒ dBm ☐ No Unit

Modulation:

☒ BPSK/QPSK ☐ BPSK ☐ 16PSK

Bit Error Rate (BER):

☐ ☐ ☐ ☐ ☐ ☒ ☐

10^{-2} 10^{-3} 10^{-4} 10^{-5} 10^{-6} 10^{-7} 10^{-8}

Calculate




Figure 9: Third question third scenario

Fourth question:

Throughput in percent of Multiple Access techniques:

After making the user enter the inputs then click calculate the outputs will show based on these equations:

"Throughput of Pure ALOHA": $\text{throughput} = G \times T \times e^{(-2 \times G \times T)}$

"Throughput of slotted ALOHA": $\text{throughput} = G \times T \times e^{(-G \times T)}$

"Throughput unslotted nonpersistent CSMA": $\text{throughput} = \frac{(G \times e^{(-2 \times \alpha \times T)})}{G \times (1 + 2 \times \alpha) + e^{(-\alpha \times G)}}$

"Throughput slotted nonpersistent CSMA": $\text{throughput} = \frac{(\alpha \times G \times e^{(-2 \times \alpha \times T)})}{G \times (1 - e^{(-2 \times \alpha \times G)}) + \alpha}$

"Throughput unslotted 1-persistent CSMA": $\text{throughput} = \frac{(G \times (1 + G + \alpha \times G \times (1 + G + \frac{\alpha \times G}{2}))) \times e^{(-G \times (1 + 2 \times \alpha))}}{(G \times (1 + 2 \times \alpha) - (1 - e^{(-2 \times \alpha \times G)}) + (1 + \alpha \times G) \times e^{(-G \times (1 + \alpha))})}$

First scenario:

The screenshot displays a web application titled "Network Throughput Calculator". On the left, there is a sidebar with several calculator options: "Complex and Quantizer Calculators", "Resource Elements Calculators", "Power Transmission Calculators", "Multiple Access Throughput Calculators" (highlighted in pink), and "Cellular System Design Calculators". Below these are the names "Mariam, Hamad - 1200837" and "Leena Affewi - 1200335". The main area is divided into three sections: "Inputs", "Results", and a "Calculate" button at the bottom. The "Inputs" section contains: "Data Transmission (BW):" with a value of 20 and units kbps, Mbps, Gbps; "Type of Calculation:" with a dropdown menu set to "Throughput unslotted nonpersistent CSMA"; "Maximum Signal Propagation time:" with a value of 40 and units Seconds (sec), milliseconds (msec), microseconds (µsec); "Frame Size:" with a value of 10 and units bits, kilobits (Kb), Megabits (Mb); and "Frame Rate:" with a value of 8 and units Frames per Second (fps), Kilo Frames per Second (Kfps), Mega Frames per Minute (Mfpm). The "Results" section shows "Throughput (%):" with a value of 67.22186073650829 %.

Figure 10: Fourth question first scenario

Second scenario:

Network Throughput Calculator

Calculator icon

Sampler and Quantizer Calculator

Resource Elements Calculator

Power Transmission Calculator

Multiple Access Throughput Calculator

Cellular System Design Calculator

Mariam Hamad - 1200837

Leena Aljoudi - 1200335

Inputs:

Data Transmission (BW): kbps, mbps, Gbps

Type of Calculation:

Maximum Signal Propagation Time: Seconds (sec), milliseconds (msec), microseconds (usec)

Frame Size: bits, kilobits (kb), Megabits (Mb)

Frame Rate: Frames per Second (fps), Kilo Frames per Second (Kfps), Frames per Minute (fpm)

Results:

Throughput (%):

Calculate

Figure 11: Fourth question second scenario

Third scenario:

Network Throughput Calculator

Calculator icon

Sample and Quantizer Calculator

Resource Elements Calculator

Power Transmission Calculator

Multiple Access Throughput Calculator

Cellular System Design Calculator

Mariam Hamad - 1200837

Zeena Alfawzi - 1200335

Inputs:

Data Transmission (BW): kbps, Mbps, Gbps

Type of Calculation:

Maximum Signal Propagation Time: Seconds (sec), milliseconds (msec), microseconds (usec)

Frame Size: bits, Kilobits (KB), Megabits (MB)

Frame Rate: Frames per Second (fps), Kilo Frames per Second (Kfps), Frames per minute (fpm)

Results:

Throughput (%):

Calculate

Figure 12: Fourth question third scenario

Fifth question:

Design of cellular system:

After making the user enter the inputs then click calculate the outputs will show based on these equations:

$$\text{max Distance} = \text{ref Distance} \times \left(\frac{\text{probD0}}{\text{receiver Sensitivity}} \right)^{\left(\frac{1}{\text{path Loss Exponent}} \right)}$$

$$\text{cell Size} = \left(\frac{3 \times \sqrt{3}}{2} \right) \times (\text{max Distance}^2)$$

$$\text{number Cells} = \frac{\text{city Area}}{\text{cell Size}}$$

$$\text{system Traffic} = \frac{\text{num Users} \times \text{calls Per Day} \times \text{call Duration}}{(24 \times 60)}$$

$$\text{traffic Per Cell} = \frac{\text{system Traffic}}{\text{num Cells}}$$

$$\text{cells Per Cluster} = \frac{(\text{minimum SIR} \times \text{co Channel Cells})^{\left(\frac{2}{\text{path Loss Exponent}} \right)}}{3}$$

$$\text{min number of carrier} = \frac{\text{the number of channel for the GOS probability with the traffic load for each cell in earlang table}}{\text{number of channel in timeslot}}$$

First scenario:

Network Throughput Calculator

Simplex and Quantizer Calculators
Distance Elements Calculators
Power Transmission Calculators
Multiple Access Throughput Calculators
Cellular System Design Calculators

Muhammad Hamad - 1200837
Ezzeno Alkham - 1200335

Network Configuration Inputs:

Type of Erlang Formula:

Number of Channels (time slots per carrier):

City Area:

Number of Users:

Number of Calls Per Day:

Call Duration:

GOS Probability:

Minimum SIR:

Reference Distance from Base Station (d0):

Probability of d0:

Path Loss Exponent:

Receiver Sensitivity:

Number of Co-Channel Interfering Cells:

Results:

Maximum Distance (m):

Maximum Cell Size (m²):

Number of Cells:

System Traffic Load (Erlangs):

Traffic Load per Cell (Erlangs):

Number of Cells in Each Cluster:

Minimum Number of Carriers:

Calculate

Figure 13: Fifth question first scenario

Second scenario:

Network Throughput Calculator

Samplers and Quantizers Calculators

Resource Elements Calculators

Power Transmission Calculators

Multiple Access Throughput Calculators

Cellular System Design Calculators

Maxim Hamad - 1200837

Zeena Aljoudi - 1200335

Network Configuration Inputs:

Type of Erlang Formula:
Erlang G

Number of Channels (time slots per carrier):
8

City Area:
4

Square Meters (m²)

Square Kilometers (km²)

Number of Users:
80

Thousands

Hundred Thousands

Millions

Number of Calls Per Day:
8

Per Second

Per Minute

Per Hour

Per Day

Call Duration:
3

Seconds

Minutes

Hours

GOS Probability:
0.02

Minimum SIR:
13

No Unit

dB

dBm

Reference Distance from Base Station (d0):
10

Centimeters

Meters

Kilometers

Probability of d0:
-22

No Unit

dB

dBm

Path Loss Exponent:
3

Receiver Sensitivity:
7

Watts

Kilowatts

Microwatts

Number of Co-Channel Interfering Cells:
6

Calculate

Results:

Maximum Distance (m):
96.59781878531683

Maximum Cell Size (m²):
8443.00929612435

Number of Cells:
164.9968186868973

System Traffic Load (Erlangs):
1333.3333333333333

Traffic Load per Cell (Erlangs):
8.081903068707478

Number of Cells in Each Cluster:
8.096796684795215

Minimum Number of Carriers:
2.0

Figure 14: Fifth question second scenario

Third scenario:

Network Throughput Calculator

Samplers and Quantizer Calculator

Resource Elements Calculator

Power Transmission Calculator

Multiple Access Throughput Calculator

Cellular System Design Calculator

Mariam Hamad - 1200837

Leena Aljoudi - 1200335

Network Configuration Inputs:

Type of Erlang Formula:
Erlang B

Number of channels (time slots per carrier):
8

City Area:
4
Square Meters (m²) | Square Kilometers (km²)

Number of Users:
80
Thousands | Hundred Thousands | Millions

Number of Calls Per Day:
8
Per Second | Per Minute | Per Hour | Per Day

Call Duration:
3
Seconds | Minutes | Hours

GOS Probability:
0.05

Minimum SIR:
3
Seconds | Minutes | Hours

GOS Probability:
0.05

Minimum SIR:
13
No Unit | dB | dBm

Reference Distance from Base Station (d0):
10
Centimeters | Meters | Kilometers

Probability of d0:
-22
No Unit | dB | dBm

Path Loss Exponent:
3

Receiver Sensitivity:
-7
Watts | Kilowatts | Microwatts

Number of Co-Channel Interfering Cells:
6

Calculate

Results:

Maximum Distance (m):
96.5978187551683

Maximum Cell Size (m²):
24243.009266122435

Number of Cells:
164.9960186888973

System Traffic Load (Erlangs):
1333.3333333333333

Traffic Load per Cell (Erlangs):
8.081903063737478

Number of Cells in Each Cluster:
8.096790684795215

Minimum Number of Carriers:
1.75

Figure 15: Fifth question third scenario