A picture containing logo

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Description automatically generated**Faculty of Enigeering** **Cairo University**

**Digital Communications Project 3**

**Modulation Techniques**

Presented for **ELC 3070** MATLAB Project

**Presented to:**

**Dr.** Mohamed Khairy

**T.A:** Mohamed Khaled

|  |  |
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| (3rd Year Electronics and Electrical Communication Engineers) | |
| مجدي أحمد عباس عبد الحميد الابرق | Sec: 3 / I.D: 9210899 / BN: 36 |
| أحمد عادل يونس سيد | Sec: 1 / I.D: 9213073 / BN: 16 |
| Role of each member:  Each one of us created his own code, and in one meeting we came together on  the best version by merging the 2 codes and wrote the documentation | |

A diagram of a flowchart

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A diagram of a circle with points and numbers

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**Binary Phase Shift Keying**

**BPSK**

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Figure 1: BER vs SNR for BPSK

**Comments**

As shown in Fig. (1) the simulated value of the BER is very close to the theoretical value which is

**Quadrature Phase Shift Keying**

**QPSK**

A graph of a function

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Figure 2: BER vs SNR for QPSK

**Comments**

The theoretical BER of QPSK is the same as BER of the BPSK which is

As we notice from Fig. (2), in binary coded QPSK, the bit error rate tends to be higher compared to Gray coding. This outcome aligns with expectations since neighboring symbols in binary coding can differ by more than one bit, unlike gray coding where adjacent symbols vary by only a single bit. Consequently, Gray coding offers superior performance with lower bit error rates.

**8 - Phase Shift Keying**

**8 - PSK**

A graph of a function

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Figure 3: BER vs SNR for 8 - PSK.

**Comments**

From Fig. (3) we notice that 8-PSK has a higher BER compared to the BPSK & QPSK. Therefore, we can conclude that in General phase shift keying as the number of symbols increase (M)   
🡪 the BER will also increase.

**16 - Quadrature Amplitude Modulation**

**16 - QAM**

A graph of a function

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Figure 4: BER vs SNR for 16 - QAM.

**Binary Frequency Shift Keying**

**BFSK**

A graph of a function

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Figure 5: BER vs SNR for BFSK

**Comments**

**The Basis Function of the BFSK is**:

where

Note: represent the (number of cycles -1) of the first symbol &

Where represent the separation frequency, in most cases we deal with its minimum value

**The Baseband Equivalent Signals of the BFSK:**

Where the represent the in-phase component & represent the quadrature component

,

Therefore, in the base band we can represent the first symbol (which refer to zero) by

and represent the second symbol (which refer to one) by

**Power Spectral Density**

**For Binary Phase Shift Keying**

**PSD - BFSK**

A graph of a signal

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Figure 6: Power Spectral Density for BFSK

**Comments**

we calculate the simulated PSD from generating certain ensemble with random bits then mapping these bits to . After that we calculate the PSD and compare this result with the Theoretical PSD

**All in One**

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Figure 7: All Simulated BER vs SNR (For All Modulation Schemes)

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Figure 8: All Theoretical BER vs SNR (For All Modulation Schemes)

**Full MATLAB Code**

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**The END Thank You**