FACULTY OF ENGINEERING CAIRO UNIVERSITY COMPUTER ENGINEERING DEPARTMENT

AM and FM

Communication Project

Prepared By:	**Sec:**	**BN:**
-Evram Youssef	1	9
-Mahmoud Othman	2	21

Delivered to: TA\ Alaa Abd El-Nasser

Under supervision of: Dr\ Mikel Melek

How to run:

AM:

```
$ python3 am.py
```

FM:

```
$ octave fm.m
```

Show Plot:

```
$ python3 plot-mse.py
```

AM Code:

0- Reading the audio sample.

1- Arranging the audio file into sample rates.

2- Dividing the peek by the modulation index (0.9) to get Ac.

3- Adding Ac to the audio signal, and multiply it by Cos(Wc t).

4- Adding normal noise to the modulated signal, with different SNR [0,1, 10, 20].

5- Demodulating the signal using envelope detector, by "Hilbert" libraty.

6- Writing the output sample.wav audio file, with different SNR's.

FM Code:

1- Read sample.wav

2- Resample to 4*fc

3- Let max frequency `B` = sample rate

4- `$freqdev = \beta * B$`

5- Calculate Kf with `$kf = freqdev * 2\pi / mp$`

6- Modulate with `$modulated(t) = Ac * cos(2\pi * fc * t + kf * integration(audio(t)))$`

7- for each β (5, .1):
    a- for each SNR (0, 1, 10, 20):
        a- Add random noise relative to 1/SNR
        b- Demodulate with *fmdemod*

c- Resample back to original sample rate
d- Write to /out

Choosing The Sampling Rate:

AM:

The library used for reading the audio sample, returned a specific sampling rate, and it was audible, so no need for resampling.

FM:

'Audioread' function returns a sampling rate form the file's metadata, and another resampling ratio was chosen for better analysis which was approximate 4.

How to set Modulation Index to 0.9:

We calculated the absolute of the minimum peek of the audio file, *Am*, and then sat Ac = Am / 0.9

How to set the Deviation Ratio to 5 in FM (WBFM):

We multiplied the Sample Rate (Fm) by the Modulation index (B), and sat the frequency deviation to that.

Observation on SNR:

As SNR increases the Noise's effect decreases, this could be observed via the Plots, or simply by listening to different audio file in 'out' folder.

For Small values of B (0.1):

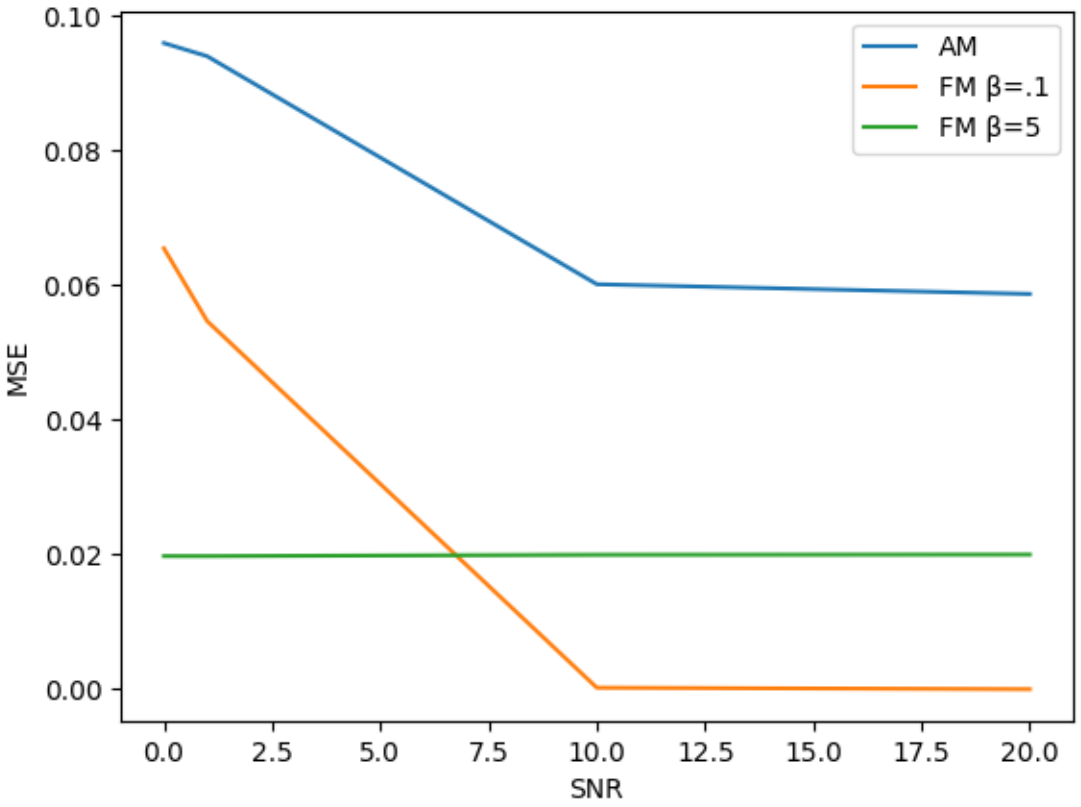
As observed from the Noise plot, for small values of SNR, small *modulation index* (deviation ratio) creates a very low quality audio, but as SNR increases, (after 10), small *modulation index* gets better than both larger B and AM.

GRAPH:

Comment:

AM results are worse than FM in general due to addition of noise.

NBFM is better than WBFM when SNR > 10, otherwise WBFM is better.


0.10
0.08
0.06
0.04
0.02
0.00
MSE
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
SNR
AM
FM β=.1
FM β=5