Report Title

Communications Systems Project

Voice Processing, Modulation, and Demodulation

Prepared By

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Sec :1

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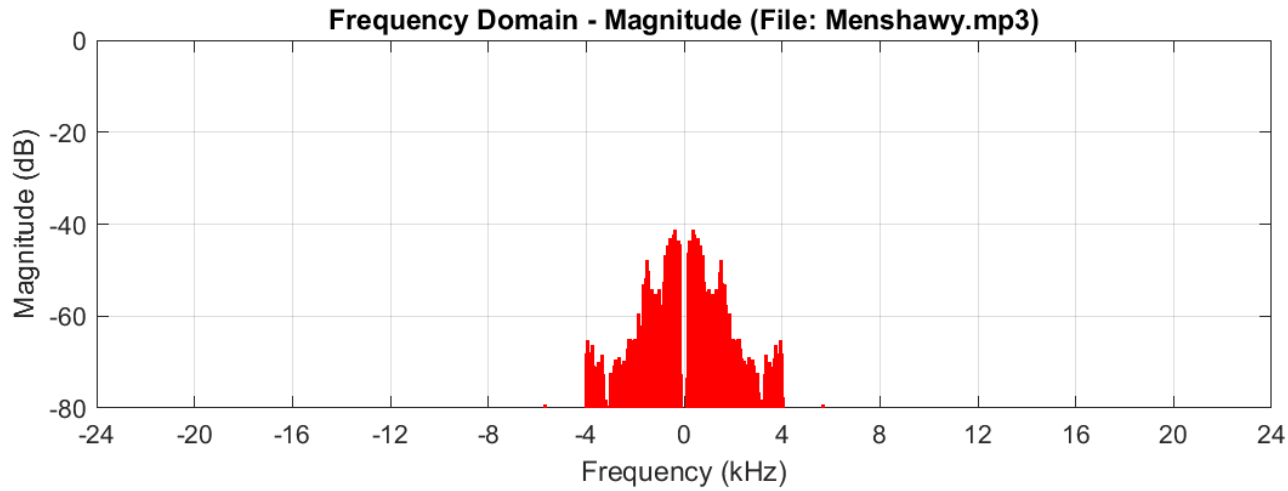
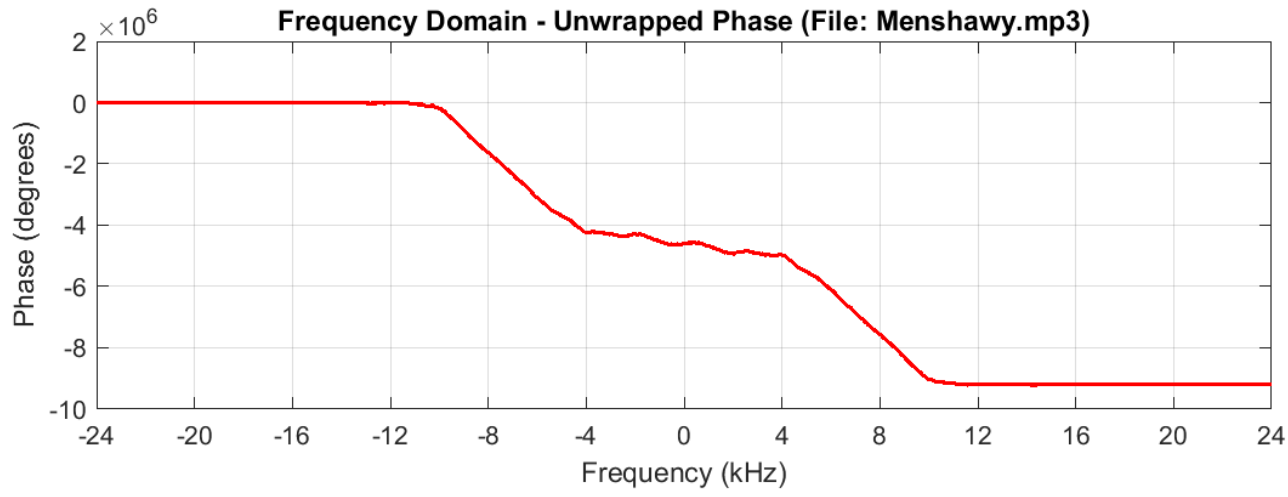
Part I:

1. Figure 1: Original Signal Analysis

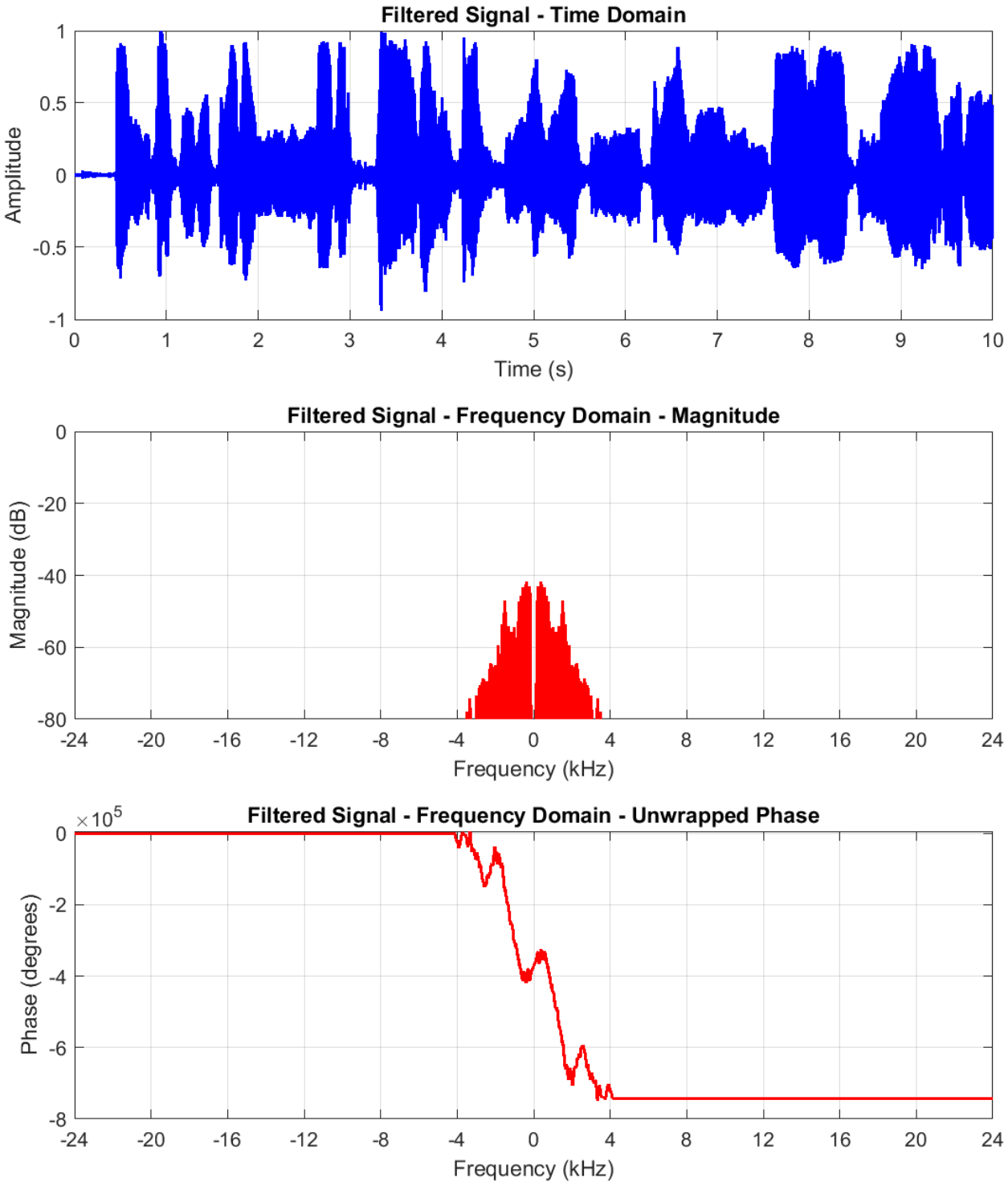
This figure (from Step 2) includes three subplots: the time-domain plot of the original voice signal (live or uploaded), the frequency-domain magnitude plot (in dB), and the unwrapped phase plot (in degrees), with the frequency axis in kHz. The title reflects the signal's origin (live recording or file upload) and the types of analysis (time, magnitude, phase), matching the filename and report section (3.1 Original Signal).





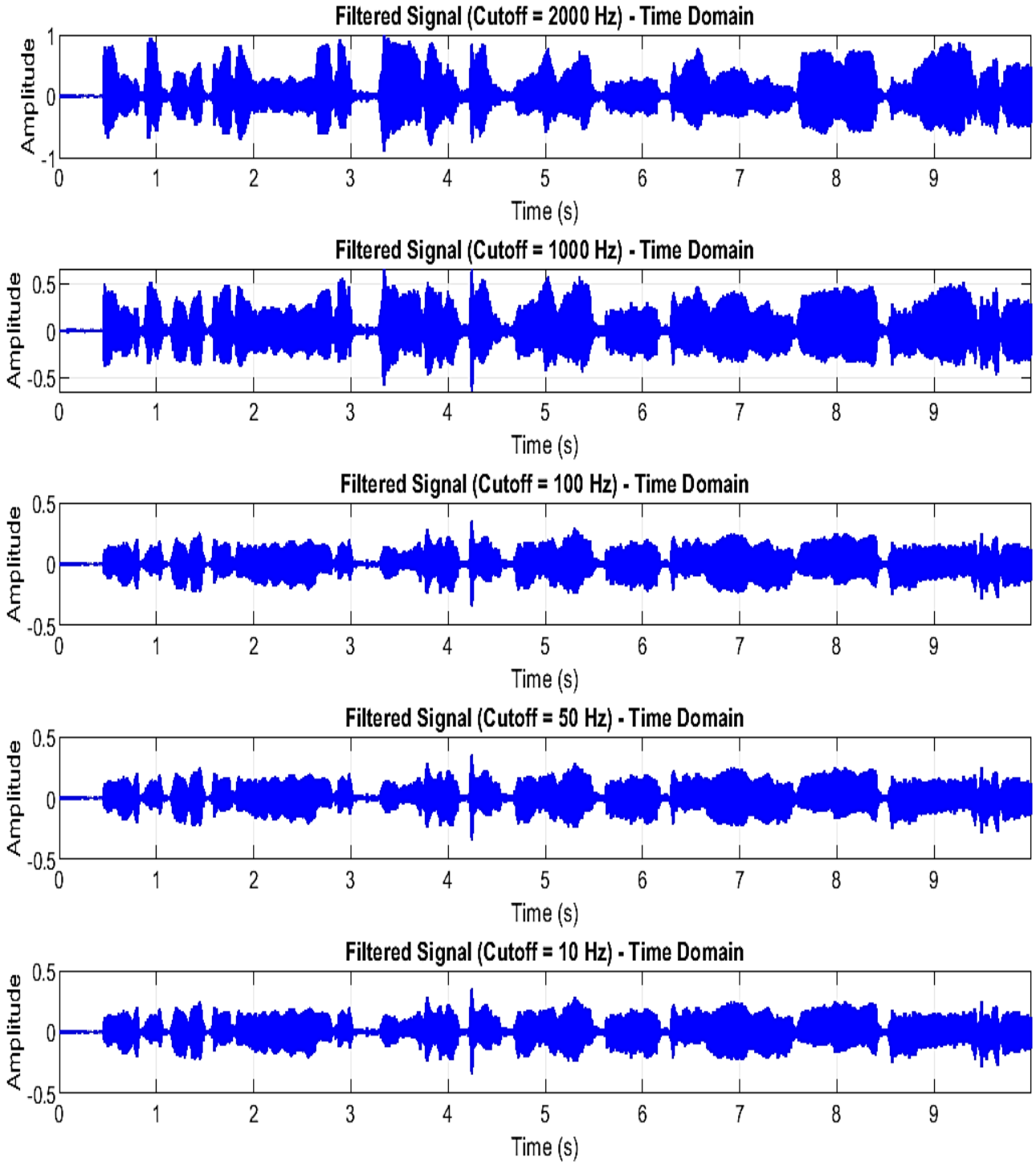
2. Figure 2: Filtered Signal Analysis (3400 Hz Cutoff)

This figure (from Step 3) includes three subplots: the time-domain plot of the voice signal after applying a 3400 Hz low-pass filter, the frequency-domain magnitude plot (in dB), and the unwrapped phase plot (in degrees), with the frequency axis in kHz. The title specifies the cutoff frequency (3400 Hz) to distinguish it from other filtered signal analyses, aligning with the filename and report section (3.2 Filtered Signal).



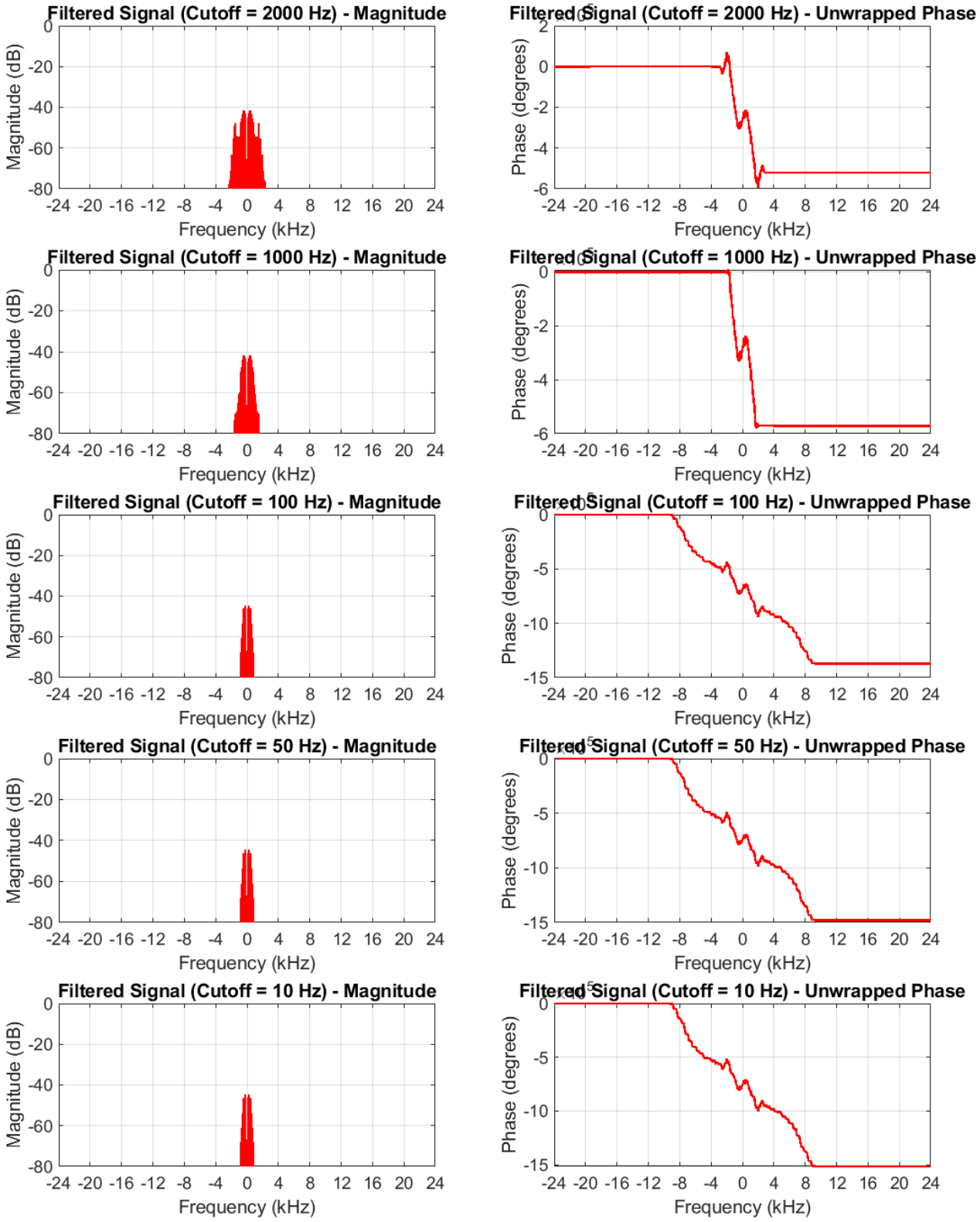
3. Figure 3: Time-Domain Analysis of Filtered Signals at Various Cutoffs

This figure (from Step 4) contains five subplots, each showing the time-domain plot of the voice signal filtered at different cutoff frequencies (2000 Hz, 1000 Hz, 100 Hz, 50 Hz, 10 Hz), with the frequency axis in kHz. The title highlights the focus on time-domain analysis across multiple cutoffs, matching the filename and report section (3.3 Test Cutoff Frequencies).



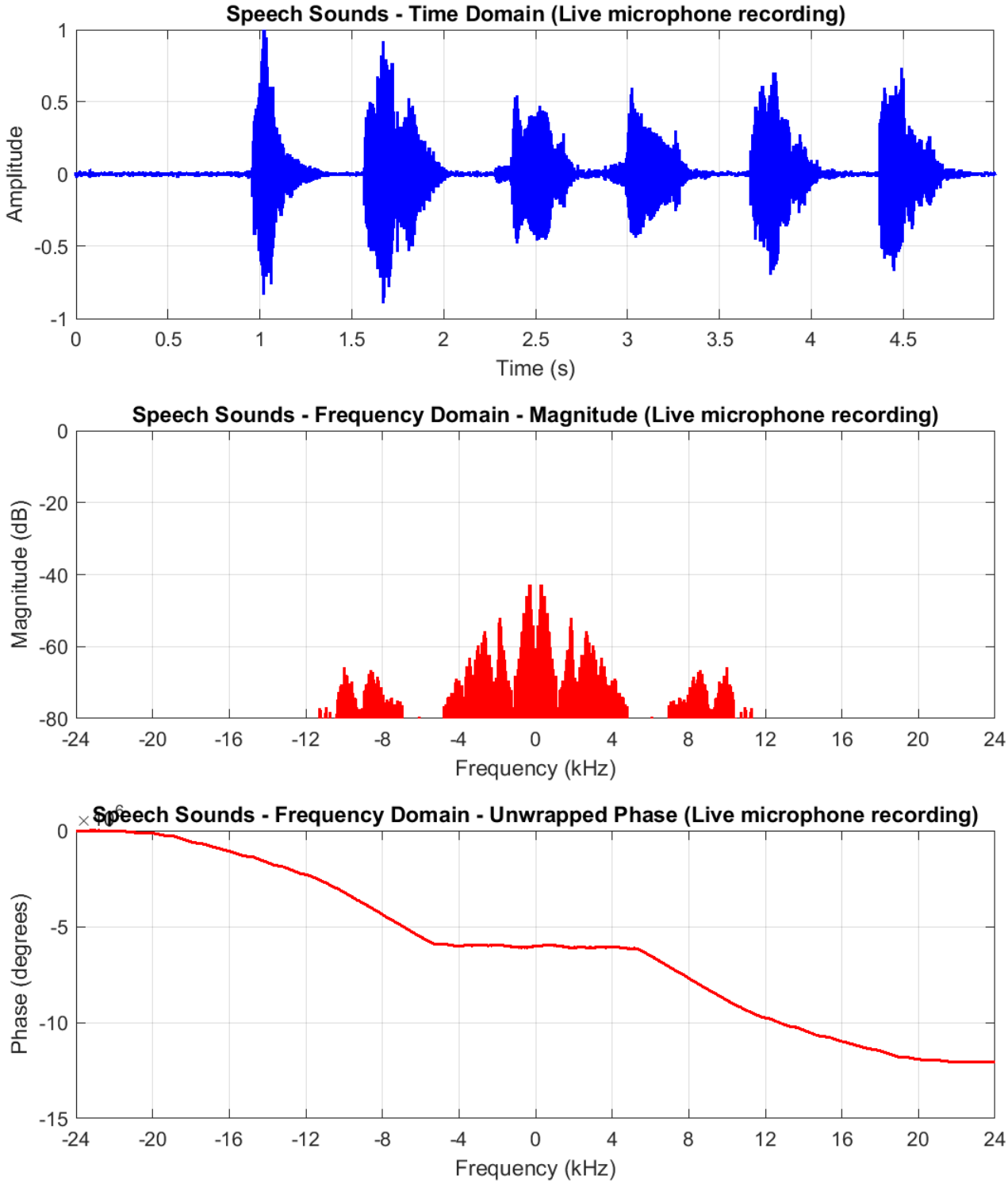
4. Figure 4: F-Domain Analysis of Filtered Signals at Various Cutoffs

This figure (from Step 4) includes ten subplots (two columns): one column for the frequency-domain magnitude plot (in dB) and one for the unwrapped phase plot (in degrees) for each cutoff frequency (2000 Hz, 1000 Hz, 100 Hz, 50 Hz, 10 Hz), with the frequency axis in kHz. The title emphasizes the frequency-domain analysis, complementing Figure 3, and aligns with the filename and report section (3.3).



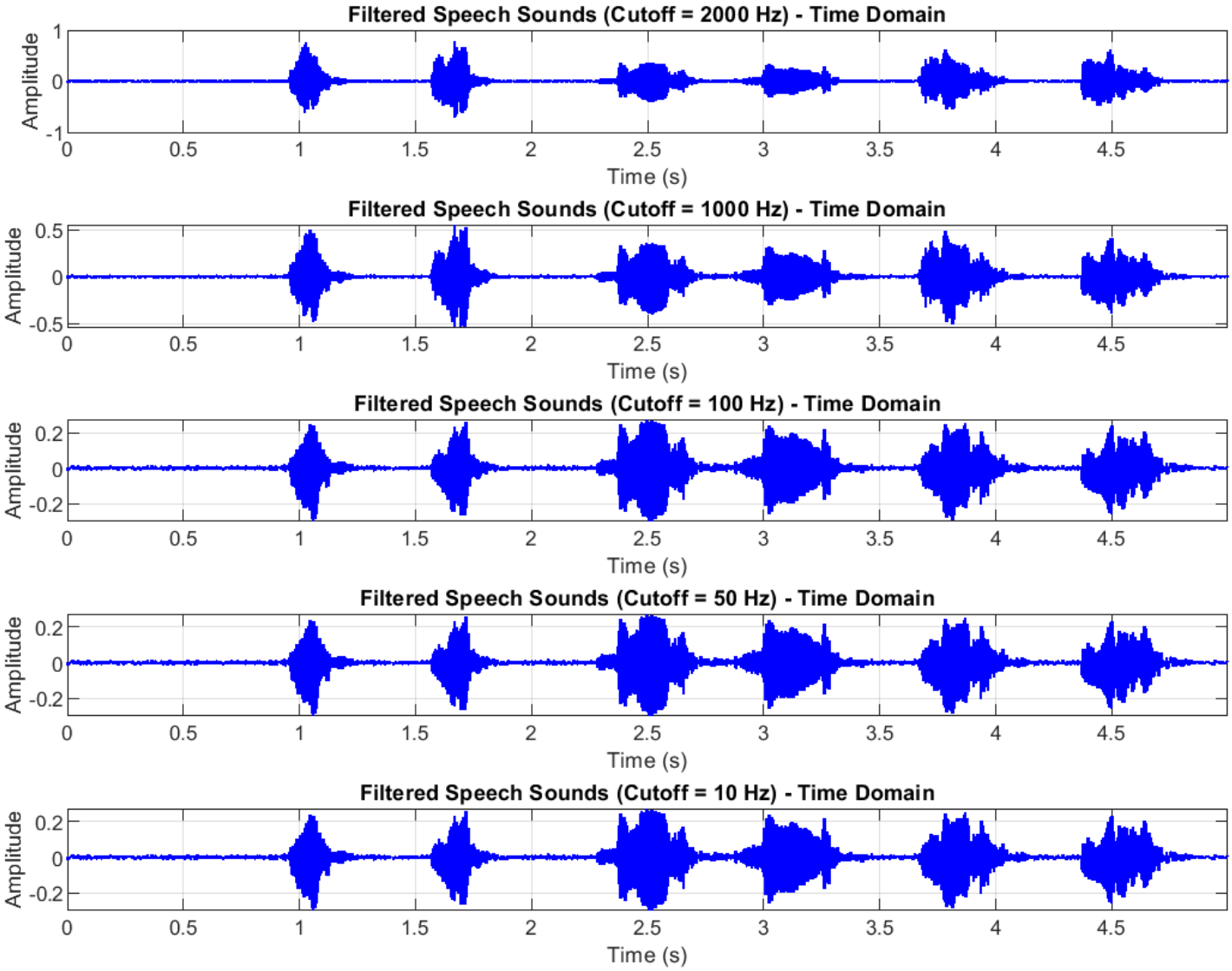
5. Figure 5: Original Speech Sounds Analysis

This figure (from Step 5) includes three subplots: the time-domain plot of the original speech sounds (f, s, b, d, n, m), the frequency-domain magnitude plot (in dB), and the unwrapped phase plot (in degrees), with the frequency axis in kHz. The title indicates the focus on the original (unfiltered) speech sounds, matching the filename and report section (3.4 Speech Sounds).



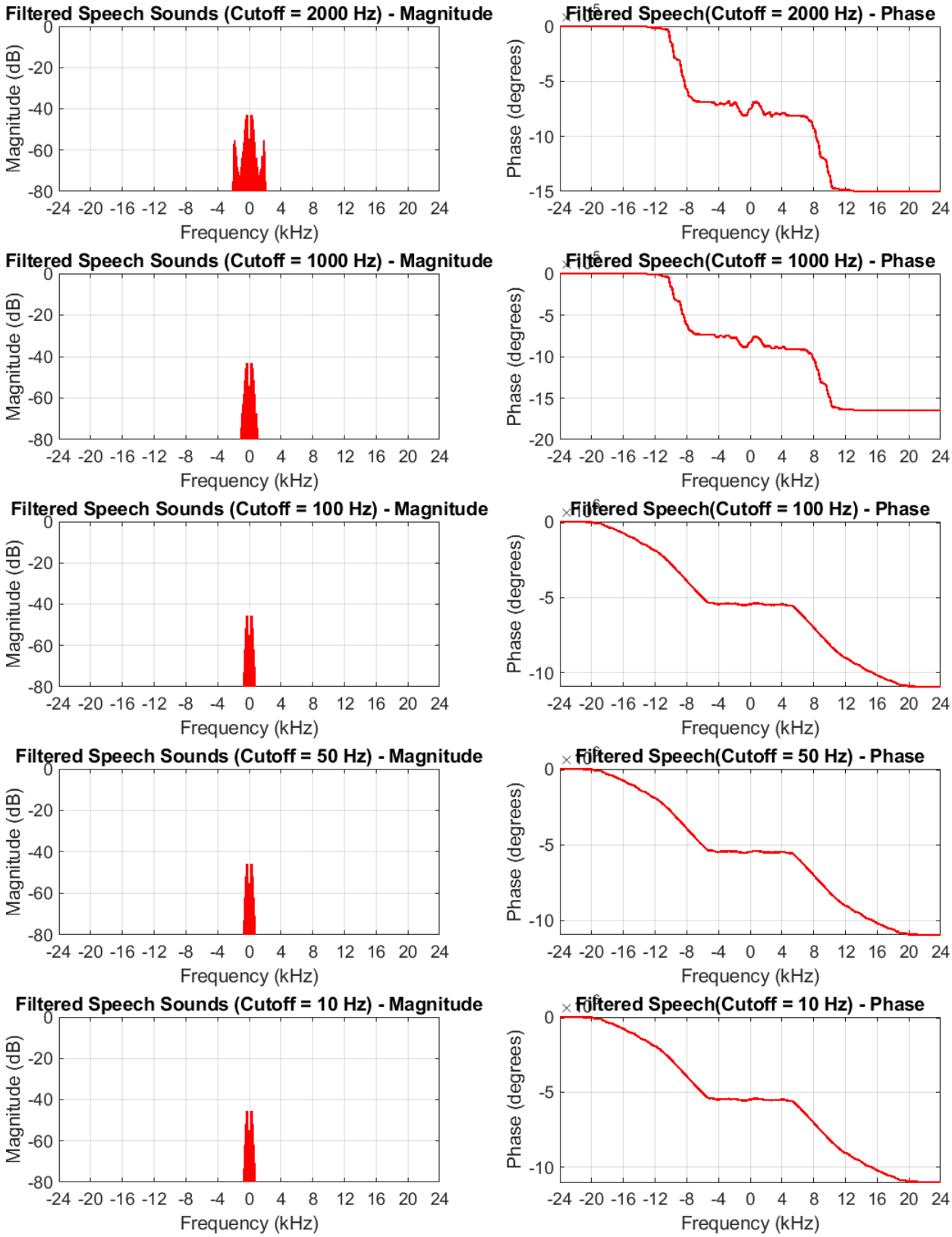
6. Figure 6: Time-Domain Analysis of Filtered Speech Sounds at Various Cutoffs

This figure (from Step 5) contains five subplots showing the time-domain plots of the speech sounds filtered at 2000 Hz, 1000 Hz, 100 Hz, 50 Hz, and 10 Hz, with the frequency axis in kHz. The title reflects the time-domain effects of filtering on speech sounds, aligning with the filename and report section (3.4).



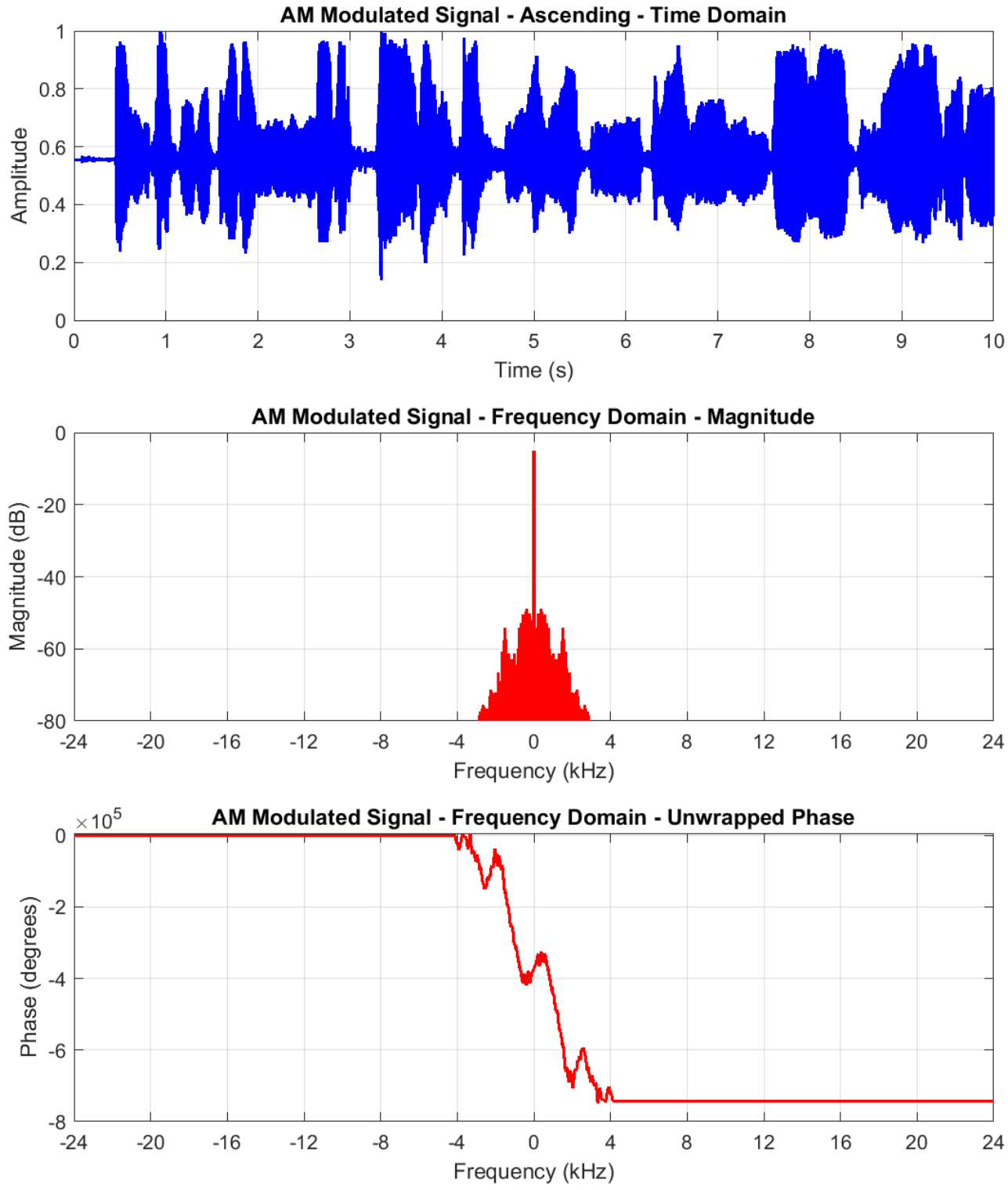
7. Figure 7: Frequency-Domain Analysis of Filtered Speech Sounds at Various Cutoffs

This figure (from Step 5) includes ten subplots (two columns) showing the frequency-domain magnitude plot (in dB) and the unwrapped phase plot (in degrees) for the filtered speech sounds at each cutoff frequency (2000 Hz, 1000 Hz, 100 Hz, 50 Hz, 10 Hz), with the frequency axis in kHz. The title complements Figure 6 by focusing on frequency-domain analysis, matching the filename and report section (3.4).



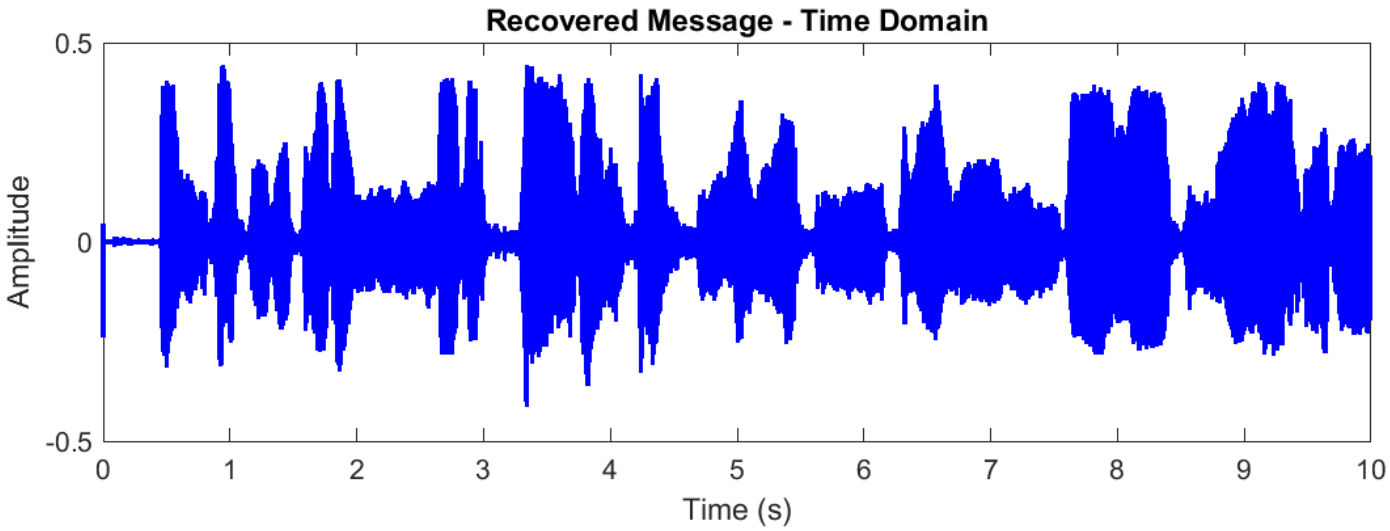
8. Figure 8: DSB-LC Modulated Signal Analysis

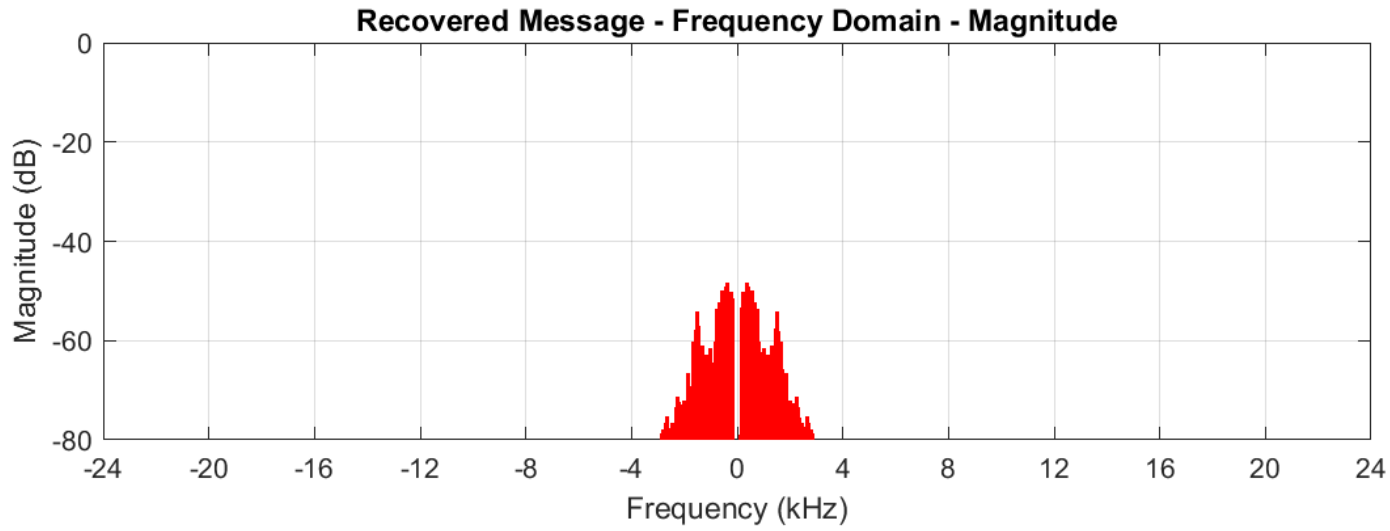
This figure (from Step 6) includes three subplots: the time-domain plot of the DSB-LC modulated signal (with (f_c = 48 kHz, (mu = 0.8)), the frequency-domain magnitude plot (in dB), and the unwrapped phase plot (in degrees), with the frequency axis in kHz. The title describes the modulated signal's analysis, aligning with the filename and report section (3.5 Modulated Signal).

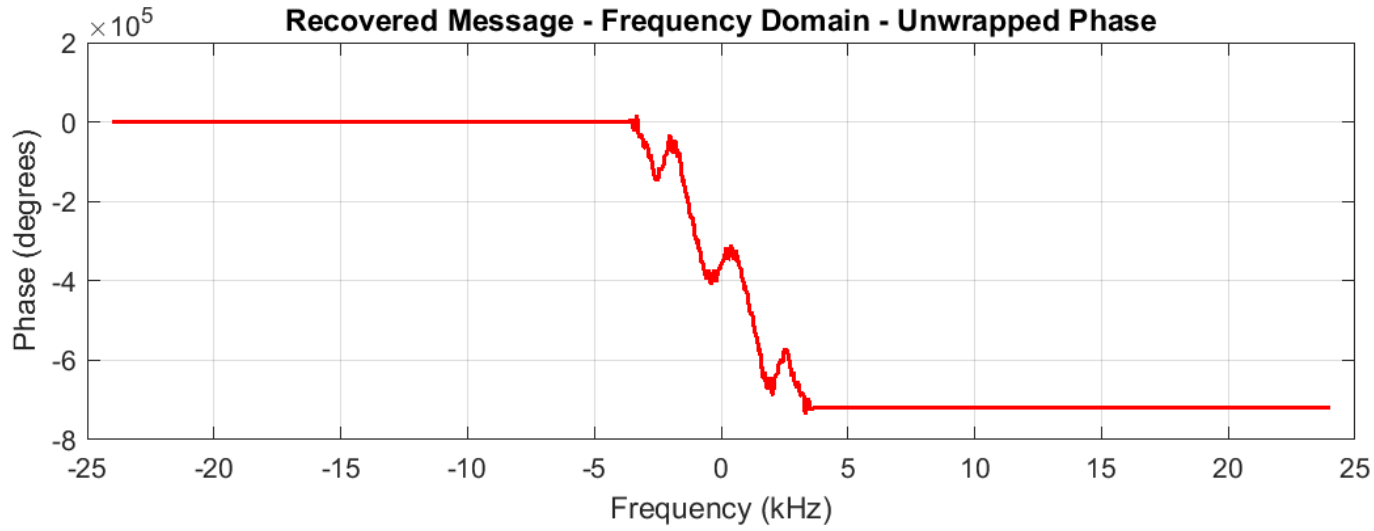


9. Figure 9: Recovered Signal Analysis via Envelope Detection

This figure (from Step 7) includes three subplots: the time-domain plot of the recovered signal after envelope detection (rectification + LPF), the frequency-domain magnitude plot (in dB), and the unwrapped phase plot (in degrees), with the frequency axis in kHz. The title highlights the envelope detection process, matching the filename and report section (3.6 Demodulated Signal).

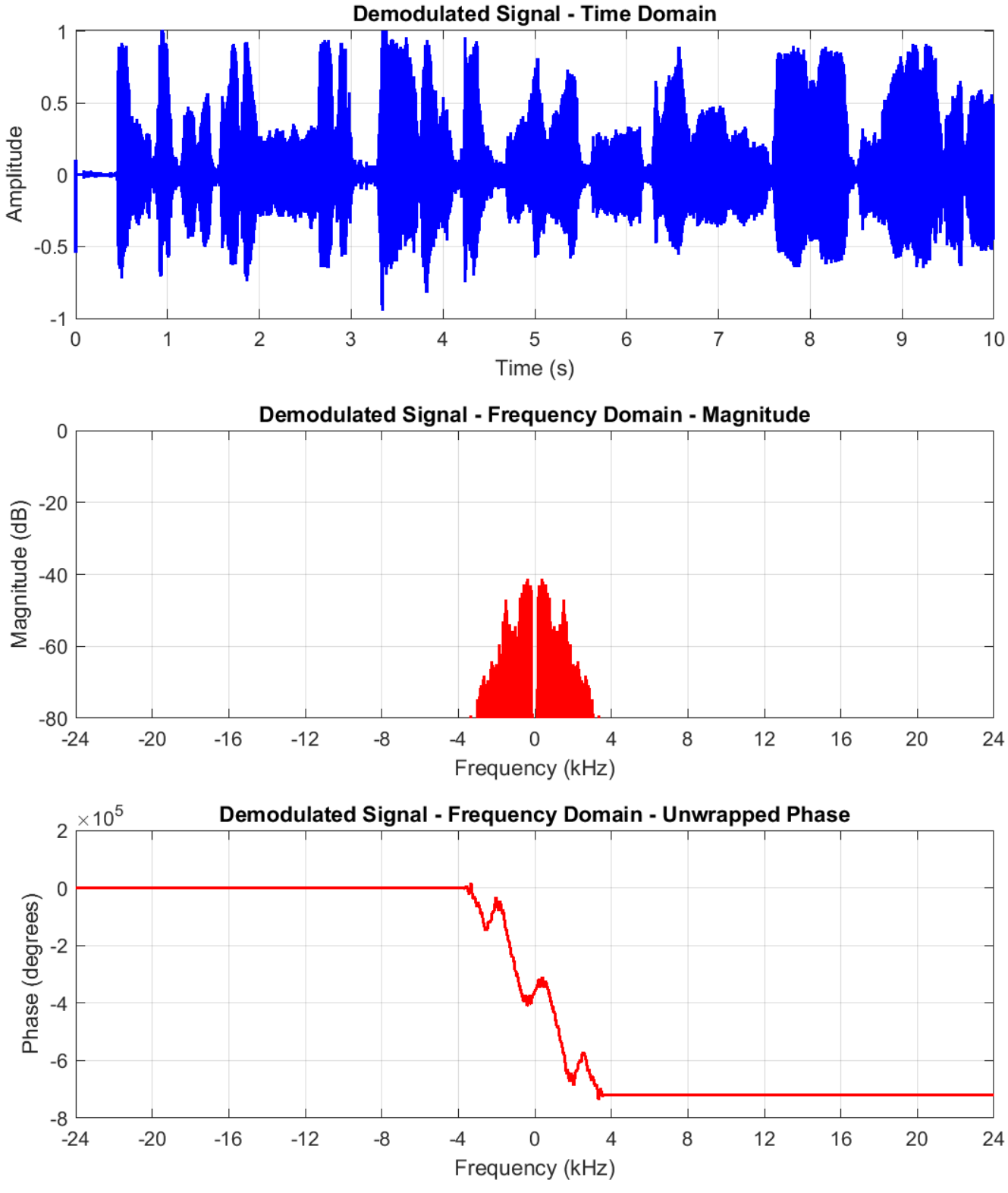




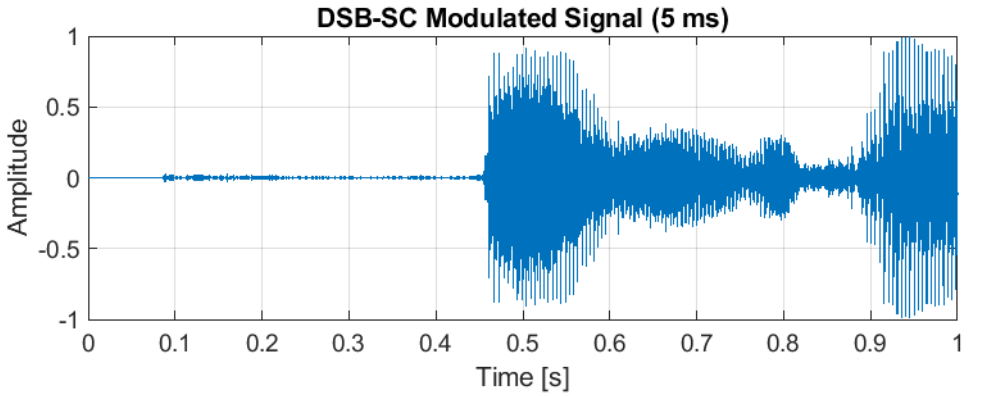


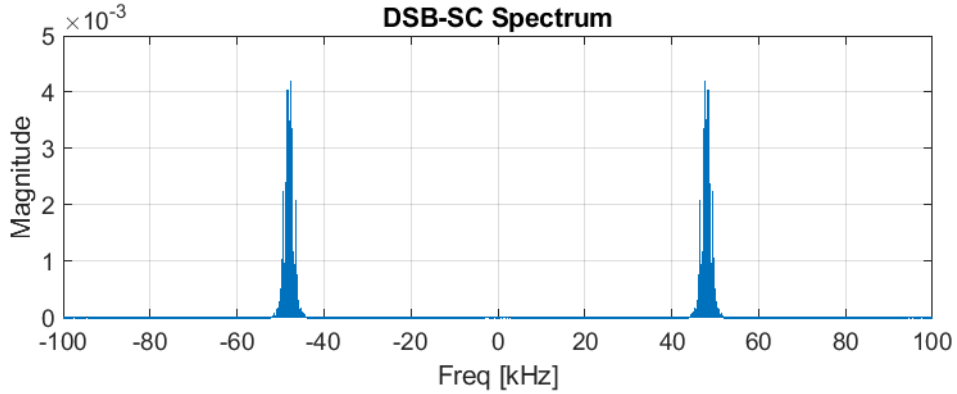
10. Figure 10: Final Demodulated Signal Analysis (Energy Scaled)

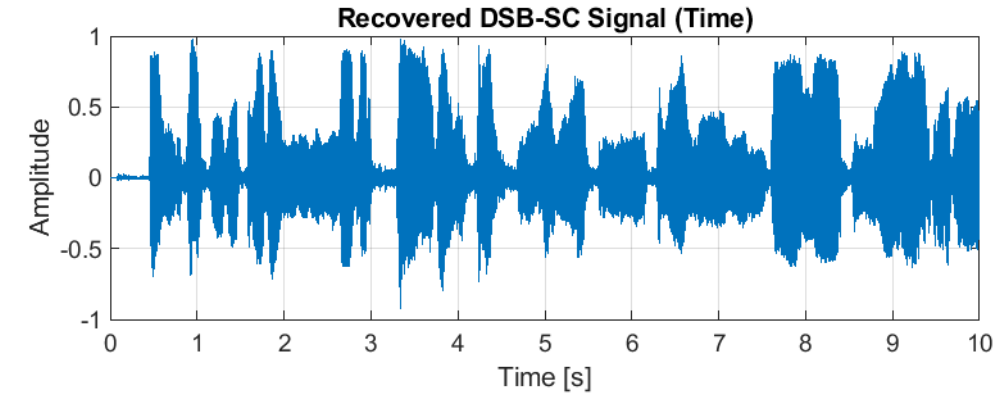
This figure (from Step 9) includes three subplots: the time-domain plot of the final demodulated signal after energy scaling, the frequency-domain magnitude plot (in dB), and the unwrapped phase plot (in degrees), with the frequency axis in kHz. The title emphasizes the final demodulated signal with energy matching, aligning with the filename and report section (3.6).

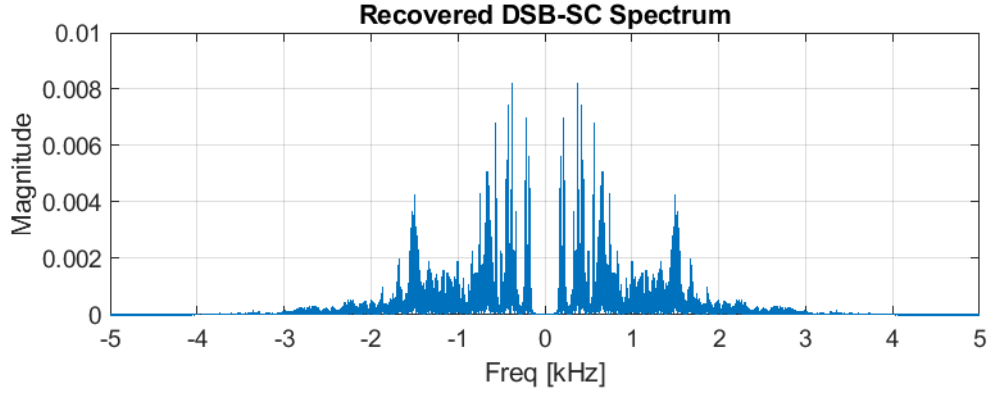


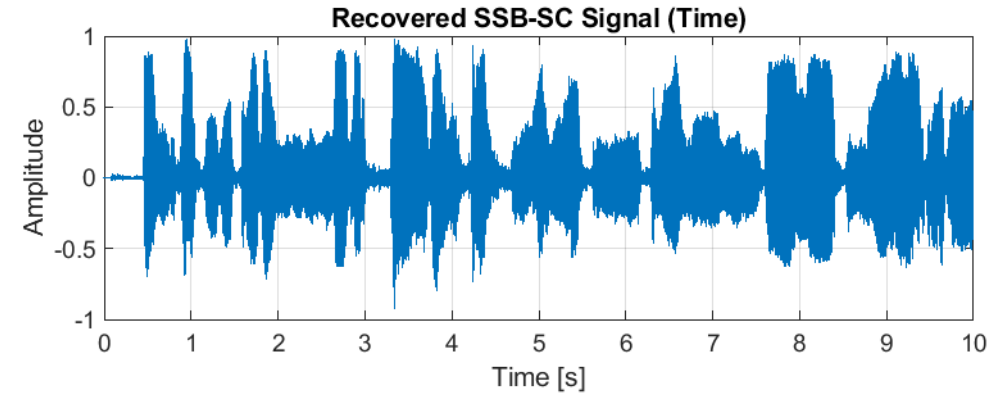
Part II:

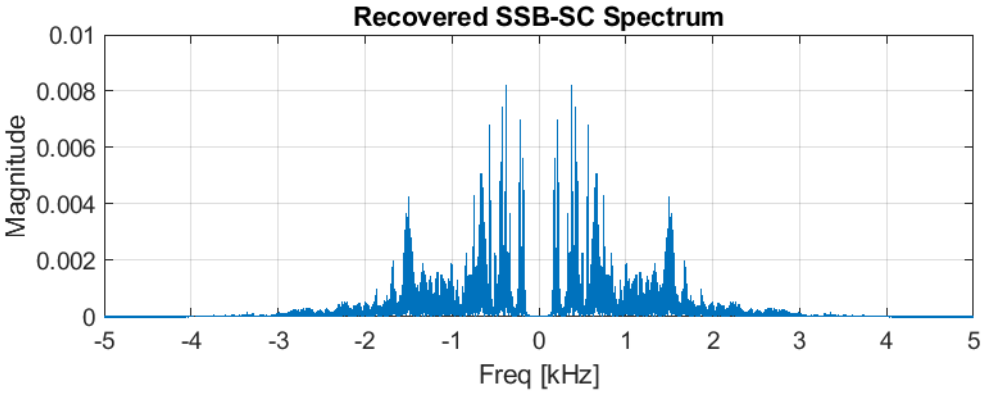

DSB-SC Modulated Signal (5 ms)
Amplitude
Time [s]

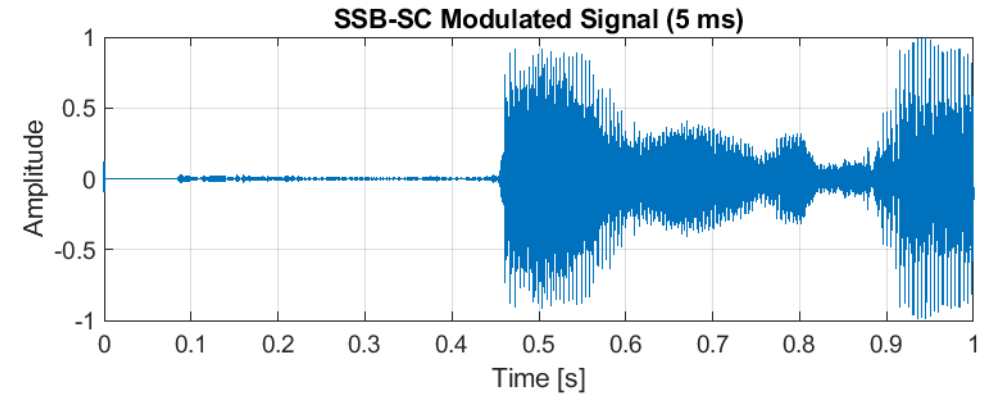

DSB-SC Spectrum
×10^-3
Magnitude
Freq [kHz]

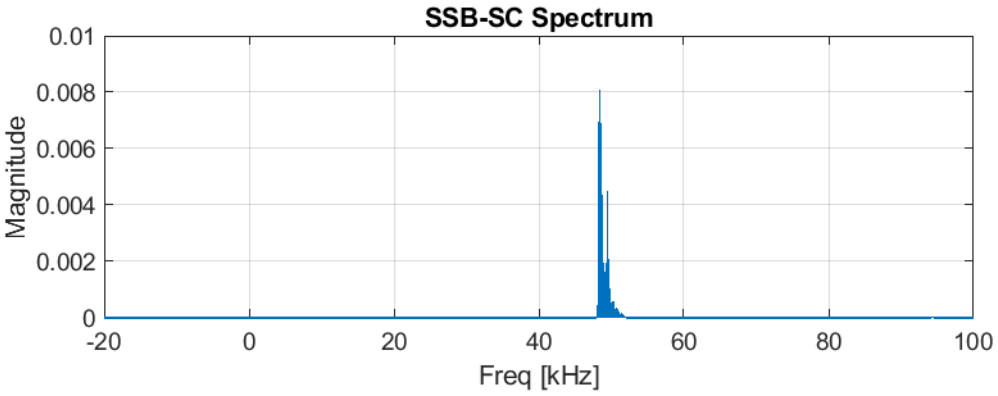

Recovered DSB-SC Signal (Time)
Amplitude
Time [s]


Recovered DSB-SC Spectrum
Magnitude
Freq [kHz]

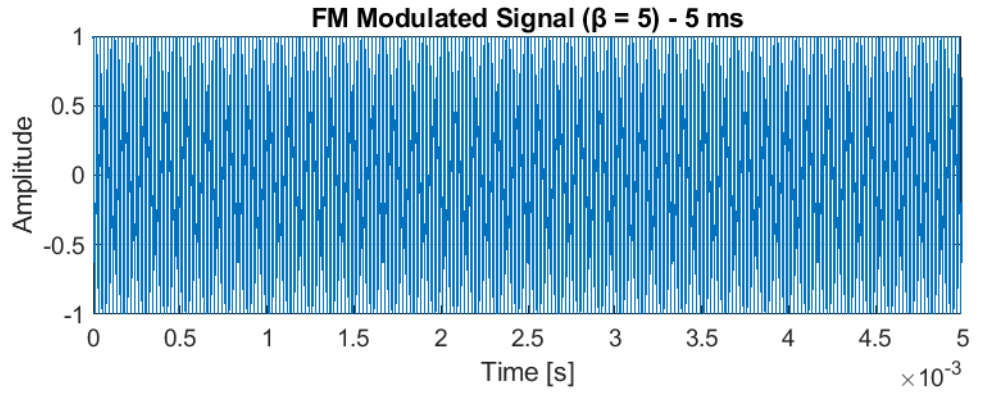

Recovered SSB-SC Signal (Time)
Amplitude
Time [s]

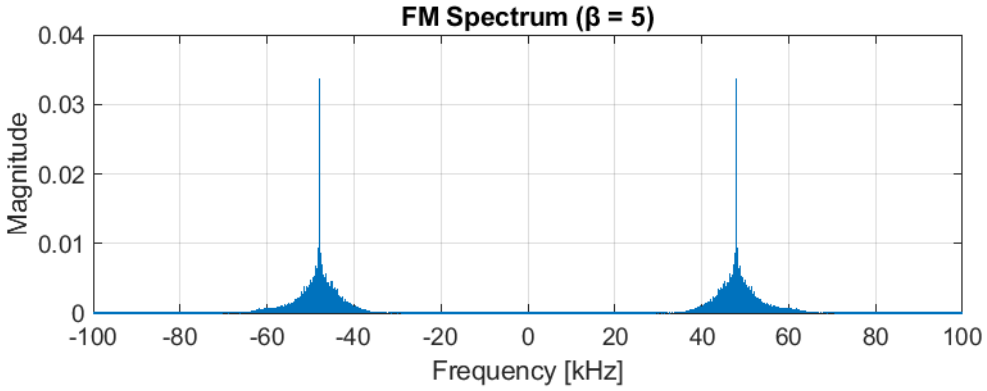

Recovered SSB-SC Spectrum
Magnitude
Freq [kHz]

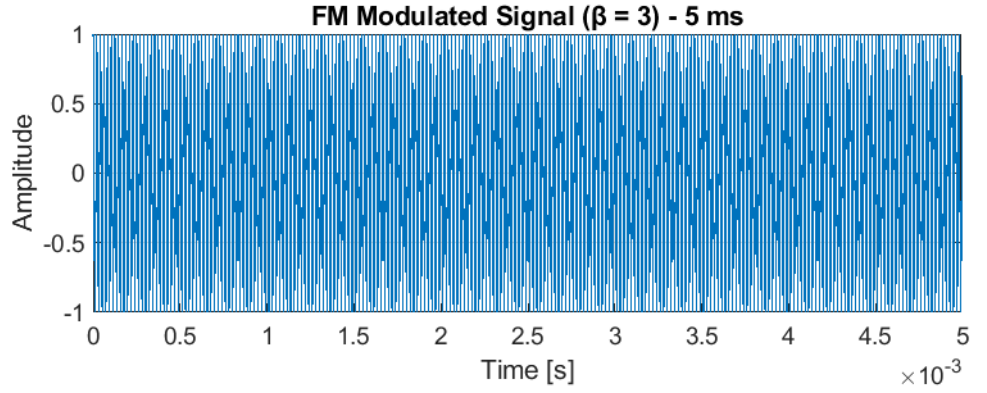

SSB-SC Modulated Signal (5 ms)
Amplitude
Time [s]

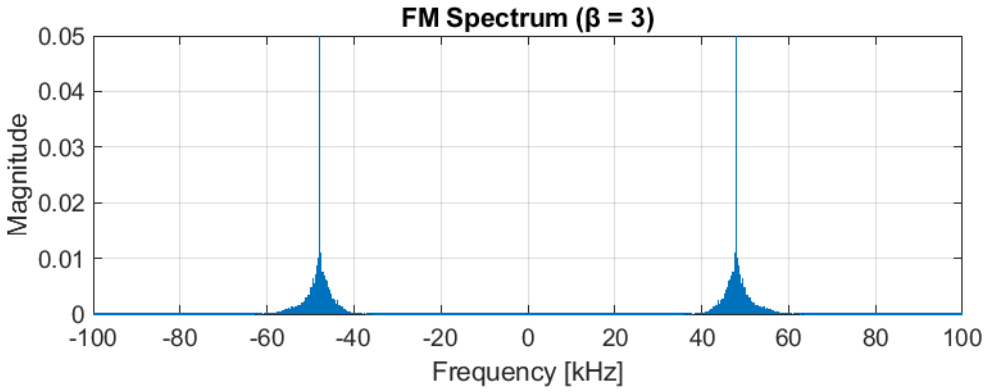

SSB-SC Spectrum
Magnitude
Freq [kHz]

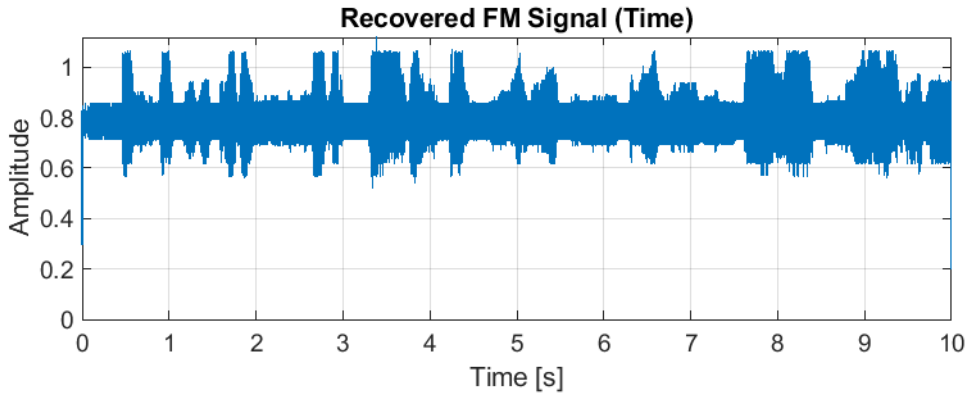
Part III:

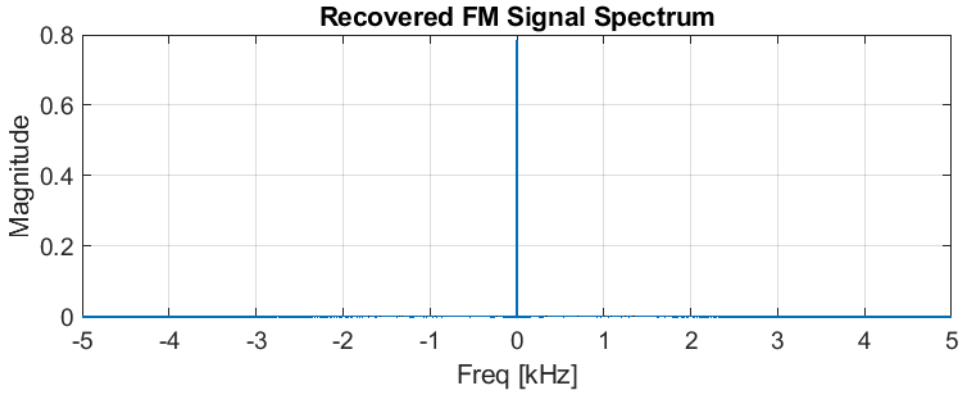

FM Modulated Signal (β = 5) - 5 ms
Amplitude
Time [s]
×10^-3

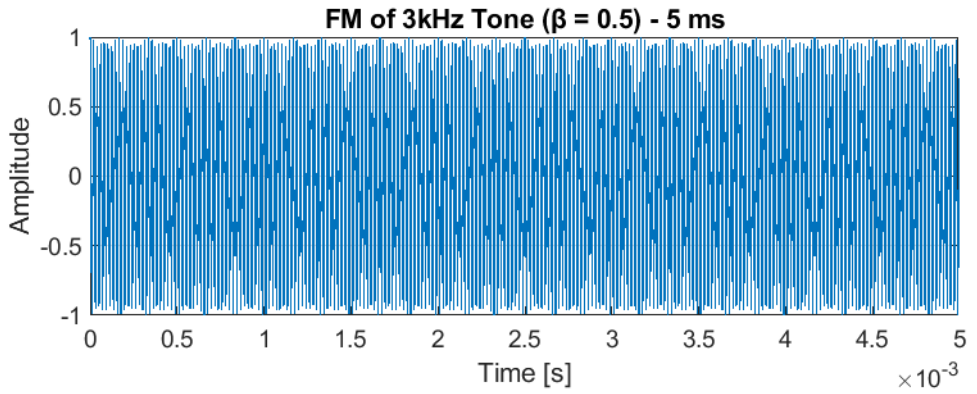

FM Spectrum (β = 5)
Magnitude
Frequency [kHz]

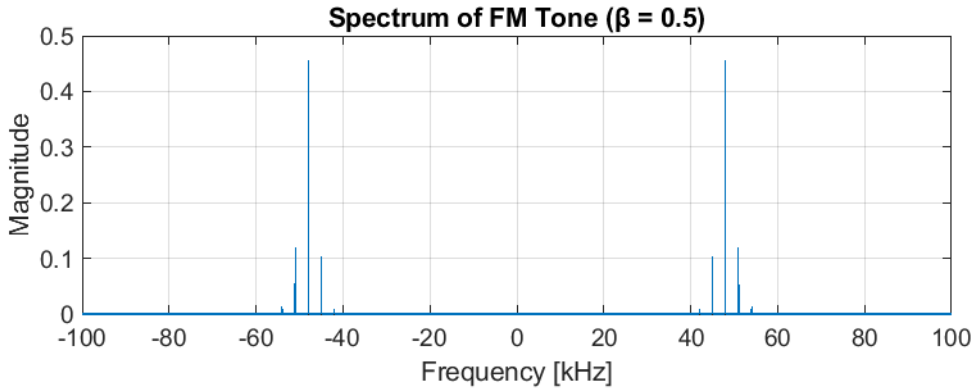

FM Modulated Signal (β = 3) - 5 ms
Amplitude
Time [s]
×10^-3

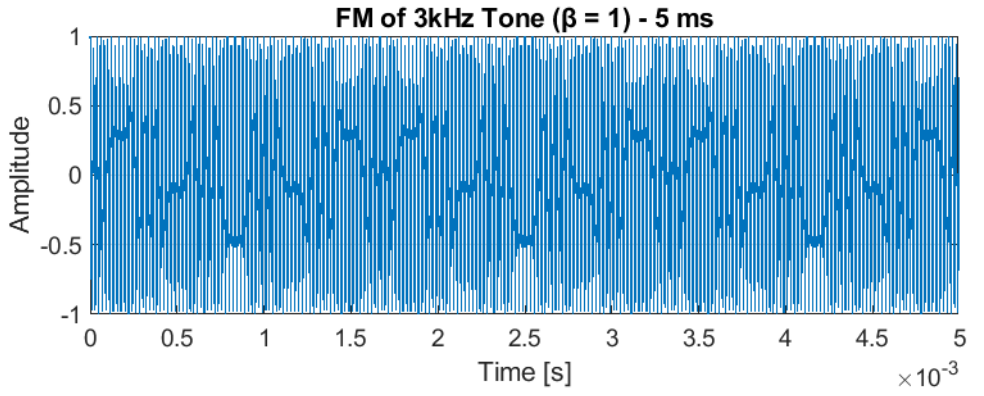

FM Spectrum (β = 3)
Magnitude
Frequency [kHz]

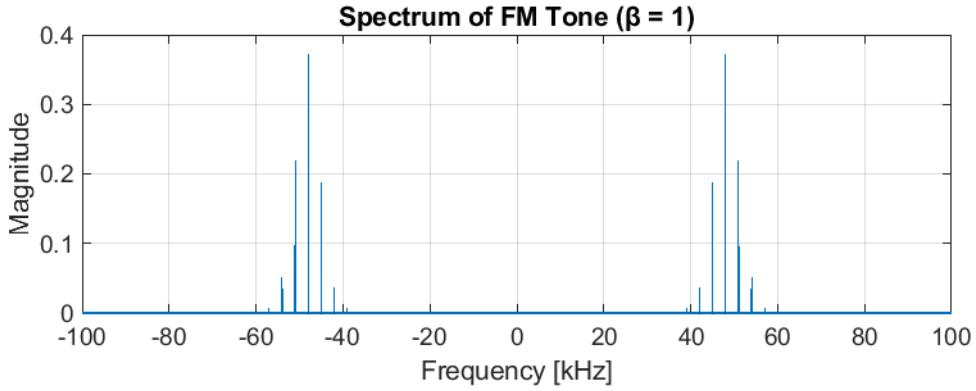

Recovered FM Signal (Time)
Amplitude
Time [s]

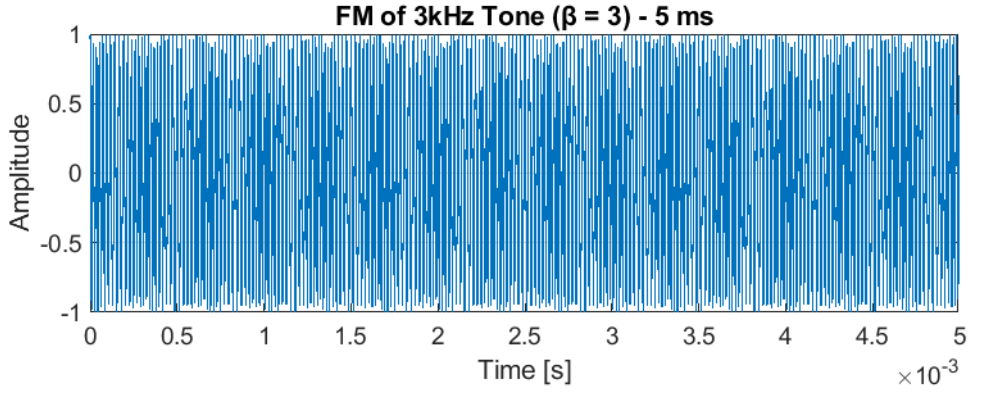

Recovered FM Signal Spectrum
Magnitude
Freq [kHz]

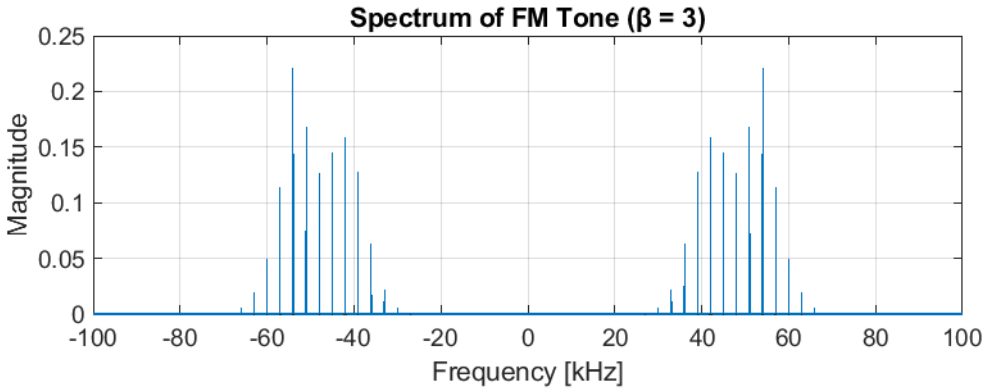

FM of 3kHz Tone (β = 0.5) - 5 ms
Amplitude
Time [s]
×10^-3

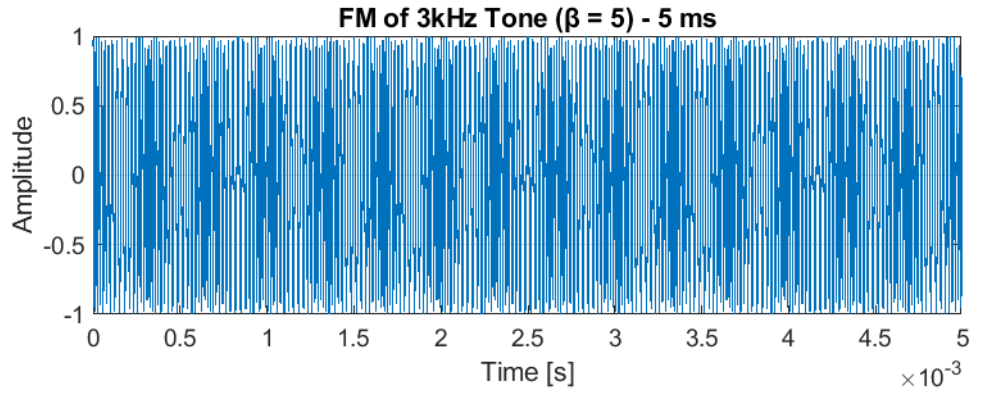

Spectrum of FM Tone (β = 0.5)
Magnitude
Frequency [kHz]

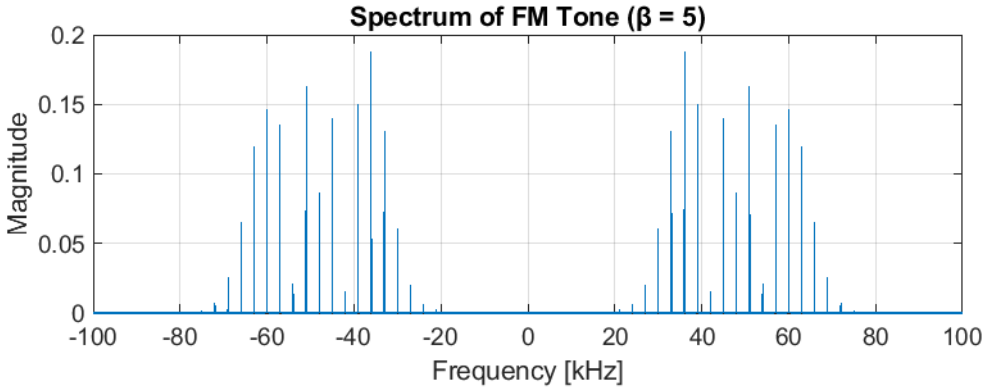

FM of 3kHz Tone (β = 1) - 5 ms
Amplitude
Time [s]
×10^-3

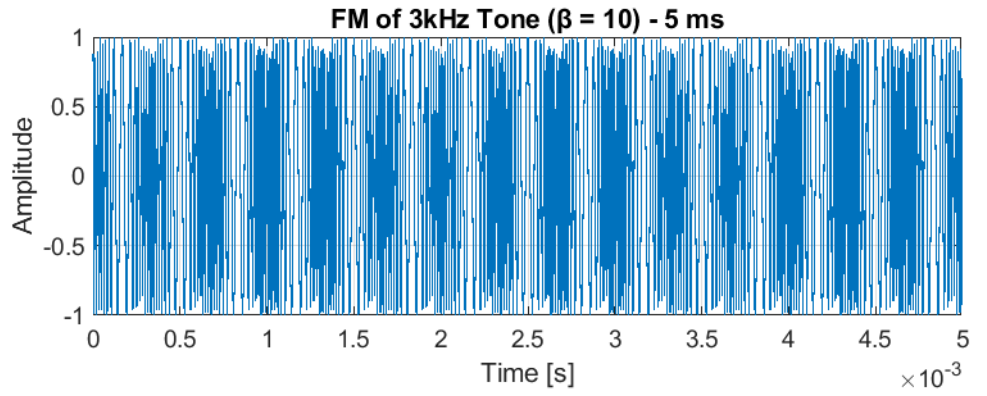

Spectrum of FM Tone (β = 1)
Magnitude
Frequency [kHz]

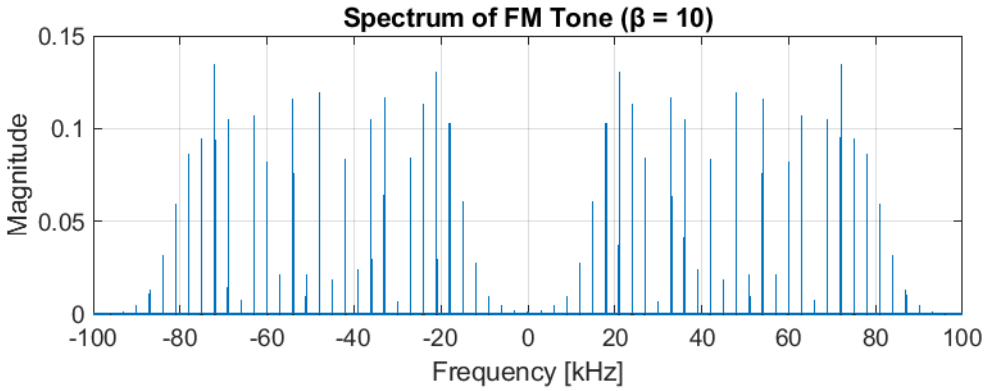

FM of 3kHz Tone (β = 3) - 5 ms
Amplitude
Time [s]
×10^-3


Spectrum of FM Tone (β = 3)
Magnitude
Frequency [kHz]


FM of 3kHz Tone (β = 5) - 5 ms
Amplitude
Time [s]
×10^-3


Spectrum of FM Tone (β = 5)
Magnitude
Frequency [kHz]


FM of 3kHz Tone (β = 10) - 5 ms
Amplitude
Time [s]
×10^-3


Spectrum of FM Tone (β = 10)
Magnitude
Frequency [kHz]

Part IV:

Threshold effect occurs at β ≈ 0.10 (SNR = 5 dB)