observations in q8_b

Observations on AM Demodulation for Different Modulation Indices (μ)

After implementing an **envelope detector** to demodulate the AM wave for modulation indices **μ = 0.5, 1, and 1.2**, the following effects were observed:

1. **For Modulation Index (μ = 0.5) [Under-Modulation]**
    - The amplitude of the modulated wave is too low compared to the carrier.
    - The envelope detector does recover the message signal, but with reduced amplitude.
    - Some distortion occurs because the carrier component is still dominant.
    - The signal is weaker, and some parts of the waveform are clipped.
2. **For Modulation Index (μ = 1) [Critical Modulation]**
    - This is the ideal case where the carrier signal just reaches zero at its lowest points.
    - The demodulated signal matches the original message signal quite well.
    - Minimal distortion is observed, making this the best case for recovery.
    - The amplitude and shape of the recovered signal are very close to the original message.
3. **For Modulation Index (μ = 1.2) [Over-Modulation]**
    - The carrier signal goes negative at some points, leading to envelope distortion.
    - The recovered message signal contains non-linearity and clipping effects.
    - Some peaks are missing or distorted because of envelope folding.
    - The shape of the recovered message deviates significantly from the original.

- **Best performance occurs at μ = 1 (critical modulation).**
- **Under-modulation (μ < 1) leads to weak recovery.**
- **Over-modulation (μ > 1) introduces severe distortion and envelope crossing, making it difficult to recover the original signal properly.**

Thus, for efficient amplitude modulation and demodulation, a modulation index **close to 1 is preferred** to achieve **optimal signal recovery** with minimal distortion.