observations in q8b:

Observations on AM Demodulation for Different Modulation Indices (μ)

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

1. **For Modulation Index ($\mu = 0.5$) [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 ($\mu = 1$) [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 ($\mu = 1.2$) [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.

Conclusion

- Best performance occurs at $\mu = 1$ (critical modulation).
- Under-modulation ($\mu < 1$) leads to weak recovery due to the low amplitude of the modulated signal.
- Over-modulation ($\mu > 1$) 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.