THE UNIVERSITY OF BRITISH COLUMBIA
Department of Electrical and Computer Engineering

ELEC 391 – Electrical Engineering Design Studio II

Amplitude Modulation – Review Questions

The purpose of this short self-quiz is to help you review the essential parts of the lectures on *Amplitude Modulation*. Most of the answers can be found in the lecture notes.

SQ3R – Survey, Question, Read, Recite, Review

Introduction

1. Where is amplitude modulation commonly used today?

2. What are the principal advantages of amplitude modulation?

3. What are the principal limitations of amplitude modulation?

4. What instrument can be used to determine the bandwidth, modulation index and efficiency of an amplitude modulated signal?

1. Amplitude Modulation

1.1. What is amplitude modulation?

Double Sideband – Suppressed Carrier

1.2. What is the double sideband – suppressed carrier modulation?

1.3. How does a DSB-SC modulator transform the spectrum of the message signal?

1.4. How does the bandwidth of a DSB-SC signal compare to that of the message signal?

1.5. How could one implement a DSB-SC modulator? Sketch and label it.

1.6. How could one implement a DSB-SC demodulator? Sketch and label it.

1.7. What does DSB-SC demodulation look like in the frequency domain?

1.8. What should the cut-off frequency of the low pass filter be?

1.9. What happens if there is a frequency or phase offset between the LOs in the modulator and demodulator?

Double Sideband – Large Carrier

1.10. What is the double sideband – large carrier modulation?

1.11. How does a DSB-LC modulator transform the spectrum of the message signal?

1.12. How does the bandwidth of a DSB-LC signal compare to that of the message signal?

1.13. How could one implement a DSB-LC modulator? Sketch and label two methods.

1.14. How could one implement a DSB-LC demodulator? Sketch and label two methods.

1.15. What are the advantages of envelope detection compared to synchronous demodulation?

1.16. What condition must be satisfied for envelope detection to be successful?

1.17. What is the modulation index?

1.18. How can one determine the modulation index by observing the DSB-LC signal in the frequency domain, i.e, by using a spectrum analyzer?

1.19. How can one determine the modulation index by observing the DSB-LC signal in the frequency domain, i.e, by using an oscilloscope?

1.20. How is the efficiency of a DSB-LC signal defined?

1.21. For the case a sinusoidal message signal, show that $\eta = \dfrac{\mu^2}{2+\mu^2}\cdot 100\%$.

Single Sideband

1.22. What is single sideband modulation?

1.23. What are the advantages and disadvantages of single sideband modulation?

1.24. Briefly, how can SSB signals be generated?

1.25. How can SSB signals be demodulated?

Quadrature Multiplexing

1.26. What is quadrature multiplexing?

1.27. What are the advantages and disadvantages of quadrature multiplexing?

1.28. Sketch and label a quadrature multiplexer and demultiplexer. Explain how it functions.

1.29. Show how the performance of a quadrature multiplexer is degraded if the phase shift between the orthogonal LO signals is not exactly 90 degrees.

2. Frequency Mixers

Applications of Frequency Mixers

2.1. List three ways in which a frequency mixer can be used to modify an RF signal.

2.2. What are the two basic types of passive mixers? What distinguishes them?

Measuring Mixer Performance

2.3. What is meant by the conversion gain of a mixer?

2.4. Why is it important to set the LO drive level correctly?

2.5. What is conversion compression and what is its significance?

2.6. Why do we normally focus on LO-x isolation measurements?

Mixers as Phase Detectors

2.7. Derive an expression that shows how we can a double-balanced mixer as a phase detector.

2.8. Sketch the transfer characteristic of a DBM-based phase detector.

2.9. What is meant by the figure of merit of a phase detector? What is a typical value?

2.10. What are other parameters of interest?

Inside a Double-Balanced Mixer

2.11. Sketch and label a ring-diode-based double-balanced mixer.

2.12. Sketch the equivalent circuit when: (a) no signal, (b) a positive DC voltage, and (c) a negative DC voltage is applied to the IF port.

2.13. Explain how one can use a double-balanced mixer as a switch, attenuator or BPSK modulator?