



Course: SEG3155/CEG3185
Semester: Winter 2012

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Assignment 2

Weight: 5%

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Due: February 13, 2012, Monday, 12:00 pm (noon)

1. [15 marks] Any periodic signal can be represented as a sum of sinusoids, known as Fourier series:

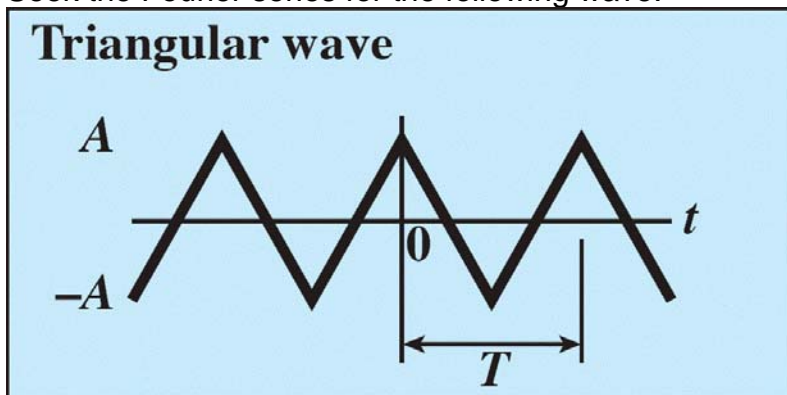
$$x(t) = \frac{A_0}{2} + \sum_{n=1}^{\infty} [A_n \cos(2\pi n f_0 t) + B_n \sin(2\pi n f_0 t)]$$

$$A_0 = \frac{2}{T} \int_0^T x(t) dt$$

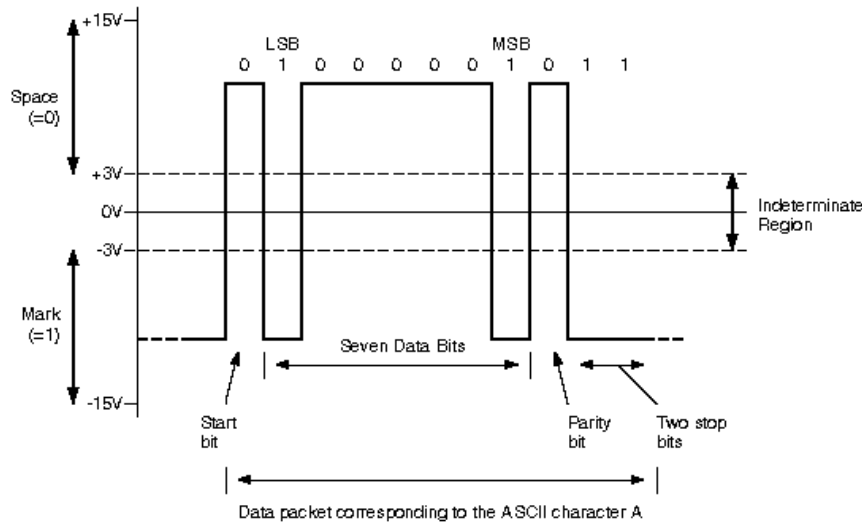
$$A_n = \frac{2}{T} \int_0^T x(t) \cos(2\pi n f_0 t) dt$$

$$B_n = \frac{2}{T} \int_0^T x(t) \sin(2\pi n f_0 t) dt$$

Seek the Fourier series for the following wave.



2. [10 marks] What encoding scheme is used in the following figure?



In the above, 7-bit ASCII character “A” is encoded as “01000001011”. What would be the resulting 11 bits for 7-bit ASCII character “C”? Use Differential Manchester, Bipolar AMI, and HDB3 schemes to represent the 11 bits for “C”. If needed, proper assumptions can be made.

3. **[10 marks]** Consider the asynchronous transmission system in the figure above that transfer N data bits (including a parity bit) between a start bit and two stop bits. If the receiver clock is 6% faster than the transmitter clock and transmitter transmits 11-bit stream “01000001011”, what 11-bit stream will be received by the receiver? For correct transmission, what is the maximum value of N if the receiver clock is 6% faster than the transmitter clock? What is the maximum value of N if the receiver clock is 1% faster than the transmitter clock?
4. **[10 marks]** The electricity supply in Canada is 110 Volts and 60 Hertz (cycles per second). Suppose we are sampling the electrical signal with a dynamic range from -120 volts to +120 volts. We want to observe up to the third harmonic. We use 1 byte to represent each PAM value. What will be the bit rate? What will be the PCM value (in binary) for two particular sampling points with a voltage of -20 volts and 102 volts respectively?
5. **[10 marks]** A CRC is constructed to generate a 5-bit FCS (frame check sequence) for a 12-bit message. The generator polynomial is $X^5 + X^4 + X^2 + 1$.
 - a. Encode the data bit sequence 100111011100 using the generator polynomial and give the codeword.
 - b. Suppose the channel introduces an error pattern 0000100000000011 (i.e., a flip from 1 to 0 or 0 to 1 in positions 5, 16, and 17 of the received data). And show that the detection algorithm detects the error.
 - c. Give an error pattern that cannot be detected by the CRC error detection scheme.
6. **[15 marks]** Use Matlab to generate the signal wave and AM wave in the following figure.

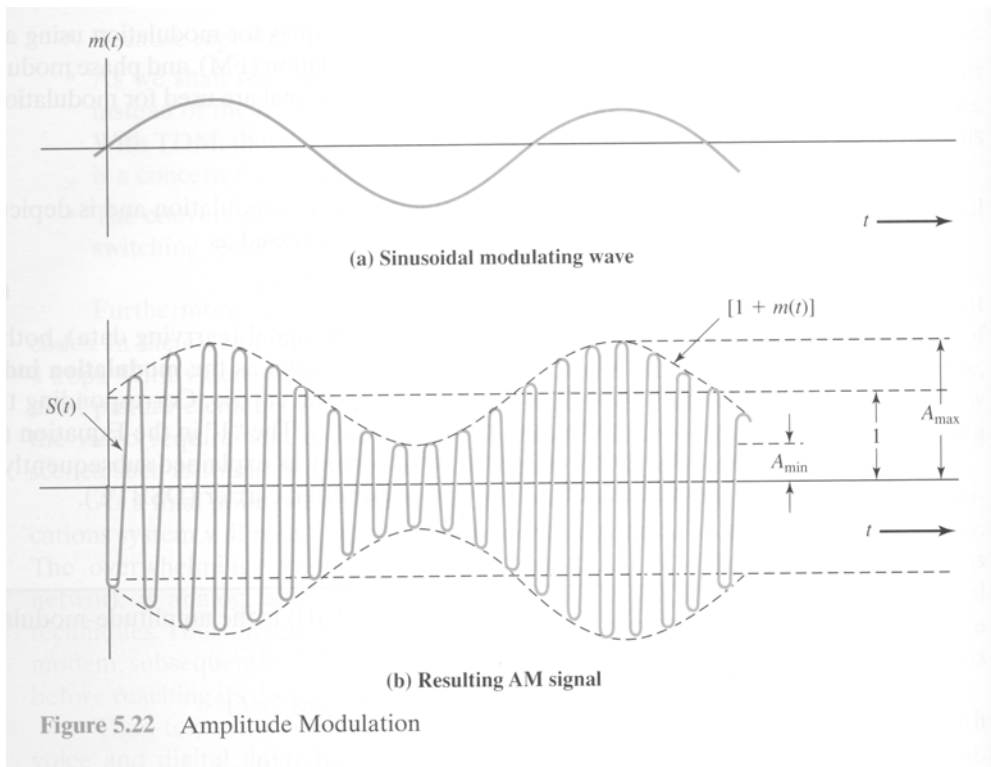


Figure 5.22 Amplitude Modulation

6. **[30 marks]** You are experimenting with the design of a digital intercom system. Using twisted pair wire, you have connected two such intercoms between your house and garage via a pair of synchronous modems. An engineer friend with access to sophisticated equipment has measured the SNR of the twisted pair line to be 40 dB and available bandwidth of 12000 Hz (note that the spectrum must be divided into two bands to allow the simultaneous (full-duplex) communications between the two intercoms).

Initially, you have set the intercom parameters to 50 dB SNR for quantization noise and PAM sampling rate of 12000 samples per second to sample the voice/music spectrum of 0-5.1 kHz.



The modems are capable of the baud rates 1200, 2400, 4800, and 9000 baud and can be configured with modulation schemes QAM-16, QAM-32, QAM-64, and QAM-128.

Can you make the intercoms work? In particular, specify the intercom parameters to deliver a suitable voice and music signal (must deliver signal spectrum 100 to 5100 Hz, with minimum 35 dB quantizing SNR) and the modem settings (baud rate and modulation scheme). Provide an explanation of your configuration.