Bonus Question: Sythnesizers

An AME student at the University of Rochester is building effects for a musical synthesizer to play with in his upcoming studio recording. Square, Triangle, Sawtooth, and Cosine waves are available for production from the synthesizer, all at the same time. Although only one is selected for the output, all are being generated at the same time, and can be accessed from jumper headers.

1. The student wants to create an effect that produces a note one octave above the note played. The student chooses to use AM modulation and a filter to create this effect. (Hint: an octave is twice the frequency of the fundamental).
   1. What signals must be used to create this effect? Calculate the resulting signal if the Cosine output is run through this effect.
   2. What filter is needed in order to cleanly create this effect with signals other than the Cosine function, and state it’s characteristic properties. Show this using graphs in the frequency domain.
2. The student now wants to make a “perfect” harmonizer. A “perfect” harmonizer is an effect that takes a signal and overlays the first four harmonics on top it.
   1. Draw a block diagram describing how this effect will work. The synth is available with it’s 4 outputs. You can use the effect of the last question as it’s own block.
   2. Draw the frequency response after each stage. (There may be more than one way to solve this)
3. The student now realizes that he can use the various signals on in his synthesizer to broadcast the music on AM radio! Draw frequency spectrums of signals to show what is happening. (Music is not necessarily from the synth. Figures below give more information on frequency content of the synth signals)
   1. If the student wants to broadcast the music with a bandwith of *w* on a certain frequency, what signal should be used as the carrier?
   2. If the student wants to broadcast the music all frequencies without spectral overlap, what signal should be used as the carrier?
   3. Assume the bandwidth of the transmitted signal does not exceed 20kHz. How can this kind of signal be demodulated? Draw a block diagram of your solution.

L = ½ \* wavelength

Square Wave



Triangle Wave



Sawtooth Wave

