

Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science
6.061/6.979 Introduction to Power Systems

Problem Set 11

Issued April 24, 2011
Due May 4, 2011

- Reading:**
1. Read Chapters 14 and 15
 2. Revisit Chapter 12, particularly sections 12.5 and 12.6

Problem 1: From Chapter 12 of the book, Problem 12

Problem 2: From Chapter 14 of the book, Problems 2 and 5

Problem 3: From Chapter 14 of the book, Problem 7

Problem 4: From Chapter 15 of the book, Problem 12

Problem 5: For 6.690 Pulse width modulation is a technique for producing waveforms that, when low-pass filtered, are nearly equivalent to continuous waveforms, but doing so with switching power electronic devices. This example is a very highly simplified version of PWM. It consists of generating a triangle waveform at some relatively high frequency and comparing that with the desired output waveform. Here we want to generate the equivalent of a 60 Hz sine wave. You can do this using your favorite mathematical assistant. I have done it using MATLAB. Using a basic time increment of 1 microsecond:

1. Start by generating a sine wave of amplitude 1 and frequency of 60 Hz. Make it two cycles long (about 33 miliseconds, so you will have about 33,000 points).
2. Now generate a triangle wave, also of amplitude 1 and frequency of 2 kHz. You will need two such waveforms, one for positive half cycles and the other for negative half cycles.
3. The output PWM waveform is +1 if the input (the sine wave) is greater than the positive triangle reference or -1 if the input is lower (more negative) than the negative triangle reference.
4. Plot the resulting waveform.
5. Now do a Fourier Analysis of the resulting waveform: What are the amplitudes of the fundamental (first harmonic) and harmonics of odd order from 1 to 25?
6. Now do the same for a peak amplitude of the refence waveform of .25. How does that change the harmonic distortion?

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