Massachusetts Institute of Technology
Department of Aeronautics and Astronautics
Cambridge, MA 02139

16.03/16.04 Unified Engineering III, IV
Spring 2004

Problem Set 13

Name: ______________________

Due Date: 5/11/04

	Time Spent (min)
CP18-20	
S16	
S17	
S18	
Study Time	

Announcements: Q7P will be on Friday, May 7 in 35-225

CP18-20

The problems in this problem set cover lecture [C17 = quiz review], C18, C19, C20

1. The operation ⊕ is defined for two Boolean variables A, B as follows:

$$A \oplus B = \overline{A}B + A\overline{B}$$

   Draw the truth table for $A \oplus B$

2. What are the minterms in the expression $A \oplus B \oplus C$?

   Hint: Use a dummy variable D for $A \oplus B$, apply the Boolean algebra theorems, then replace D with $A \oplus B$ and repeat the process.

3. Convert the following English statements into formal propositions.
    a. The killer touched both the candlestick and the wrench
    b. There are exactly 2 sets of fingerprints on the candlestick.
    c. Joe touched either the candlestick or the wrench, but not both.
    d. George only touched the candlestick.
    e. George saw Hannah touch the wrench.
    f. Hannah touched all the weapons that George touched.
    g. Hannah saw Joe touch the candlestick

   Given that there is only one killer, use resolution to identify the killer.

4. Provide a **Direct Proof** of the following, where a, b, and c are integers

   If a|b and b|c, then a|c

   Hint: definition of " | " (Divisible) is given in lecture 20.

5. Prove using induction that P(n) = P(n-1) + P(n-2), where P(n) is a Fibonacci number.

   Hint: What are Fibonacci numbers? That will help you identify the base case.

6. Prove using induction that if p does not divide any of the numbers $a_1, a_2, a_3, \ldots, a_n$ (i.e., p is not a common divisor for $a_1, a_2, a_3, \ldots, a_n$) ;then p does not divide $a_1 * a_2 * a_3 * \ldots * a_n$

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Problem S16 (Signals and Systems)

Do problem 8.8 from Openheim and Willksy, *Signals and Systems*, reprinted below:

8.8. Consider the modulation system shown in Figure P8.8. The input signal $x(t)$ has a Fourier transform $X(j\omega)$ that is zero for $|\omega| > \omega_M$. Assuming that $\omega_c > \omega_M$, answer the following questions:

(a) Is $y(t)$ guaranteed to be real if $x(t)$ is real?

(b) Can $x(t)$ be recovered from $y(t)$?

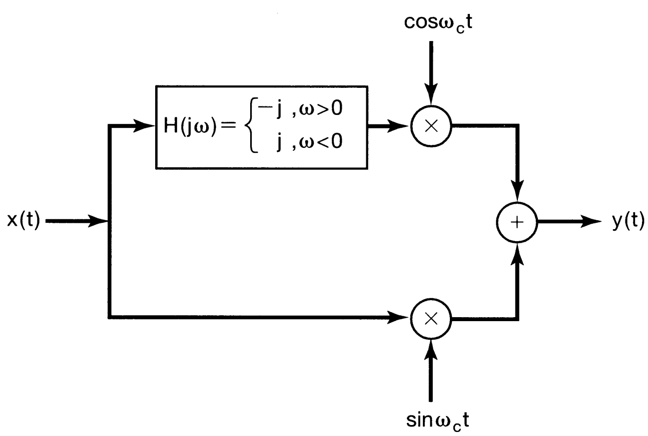

Figure P8.8

Note that this system implements a type of single sideband amplitude modulation.

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Problem S17 (Signals and Systems)

Do problem 8.26 from Openheim and Willksy, *Signals and Systems*, reprinted below:

8.26. In Section 8.2.2, we discussed the use of an envelope detector for asynchronous demodulation of an AM signal of the form $y(t) = [x(t) + A]\cos(\omega_c t + \theta_c)$. An alternative demodulation system, which also does not require phase synchronization, but does require frequency synchronization, is shown in block diagram form in Figure P8.26. The lowpass filters both have a cutoff frequency of ω_c. The signal $y(t) = [x(t) + A]\cos(\omega_c t + \theta_c)$, with θ_c constant but unknown. The signal $x(t)$ is band limited with $X(j\omega) = 0$, $|\omega| > \omega_M$, and with $\omega_M < \omega_c$. As we required for the use of the envelope detector, $x(t) + A > 0$ for all t.

Show that the system in Figure P8.26 can be used to recover $x(t)$ from $y(t)$ without knowledge of the modulator phase θ_c.

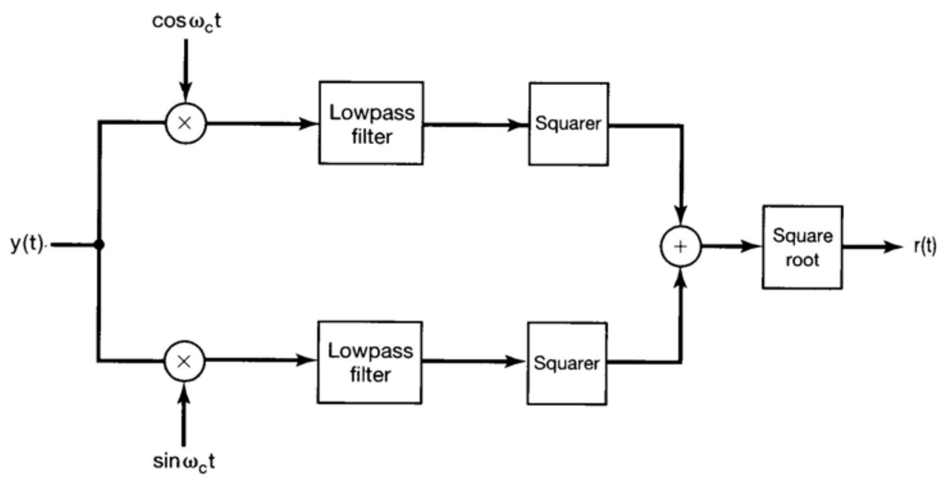

Figure P8.26

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Problem S18 (Signals and Systems)

Do problem 8.34 from Openheim and Willksy, *Signals and Systems*.