Name ________________________ ID3 _ _ _

ECS 332: Principles of Communications **2019/1**

HW 7 — Due: November 8, 4 PM

Lecturer: Prapun Suksompong, Ph.D.

Instructions

(a) This assignment has 11 pages. Problems on pages 3 to 11 are optional. They can be downloaded from the course website.

(b) (1 pt) Hard-copies are distributed in class. Original pdf file can be downloaded from the course website. Work and write your answers **directly on the provided hardcopy/file** (not on other blank sheet(s) of paper).

(c) (1 pt) Write your first name and the last three digits of your student ID in the spaces provided on the upper-right corner of this page. Furthermore, for online submission, your file name should start with your 10-digit student ID, followed by a space, the course code, a space, and the assignment number: "5565242231 332 HW7.pdf"

(d) (8 pt) Try to solve all non-optional problems.

(e) Write down all the steps that you have done to obtain your answers. You may not get full credit even when your answer is correct without showing how you get your answer.

Problem 1. Consider an AM transmitter.

(a) Suppose the message is $m(t) = 4\cos(10\pi t)$ and the transmitted signal is

m_p

$$x_{\text{AM}}(t) = A\cos(100\pi t) + m(t)\cos(100\pi t). = (A + m(t))\cos(100\pi t)$$

Find the value of A which yields the modulation index in each part below.

(i) $\mu = 50\%$ $\Rightarrow A = \frac{4}{0.5} = 8$

(ii) $\mu = 100\%$ $\Rightarrow A = \frac{4}{1} = 4$

(iii) $\mu = 150\%$ $\Rightarrow A = \frac{4}{1.5} = \frac{4}{3/2} = \frac{8}{3}$

$\mu > 100\%$ $\Rightarrow$ overmodulation, phase reversal, envelope distortion.

$\mu \equiv \frac{m_p}{A} = \frac{4}{A} \Rightarrow A = \frac{4}{\mu}$

(b) Suppose the message is $m(t) = \alpha \cos(10\pi t)$ and the transmitted signal is

$$x_{\text{AM}}(t) = 4\cos(100\pi t) + m(t)\cos(100\pi t).$$

Find the value of α which yields the modulation index in each part below.

(i) $\mu = 50\%$ — $m_p = \mu A = 0.5 \times 4 = 2$

(ii) $\mu = 100\%$ — $1 \times 4 = 4$

(iii) $\mu = 150\%$ — $1.5 \times 4 = 6$

$\mu = \frac{m_p}{A}$ $\quad m_p = \mu A$

Problem 2. Recall that, in QAM system, the transmitted signal is of the form

$$x_{\text{QAM}}(t) = m_1(t)\sqrt{2}\cos(2\pi f_c t) + m_2(t)\sqrt{2}\sin(2\pi f_c t).$$

We want to express x_{QAM} in the form

$$x_{\text{QAM}}(t) = \sqrt{2}E(t)\cos(2\pi f_c t + \phi(t)),$$

where $E(t) \geq 0$ and $\phi(t) \in (-180°, 180°]$. (This shows that QAM can be expressed as a combination of amplitude modulation and phase modulation.)

Consider $m_1(t)$ and $m_2(t)$ plotted in Figure 7.1.
Draw the corresponding $E(t)$ and $\phi(t)$.

	m_1	m_2	$m_1 - jm_2$
1	1	-1	$1+j = \sqrt{2}\angle 45°$
2	0	-1	$j = 1\angle 90°$
3	-1	0	$-1 = 1\angle 180°$
4	1	0	$1 = 1\angle 0°$
5	1	1	$1-j = \sqrt{2}\angle -45°$

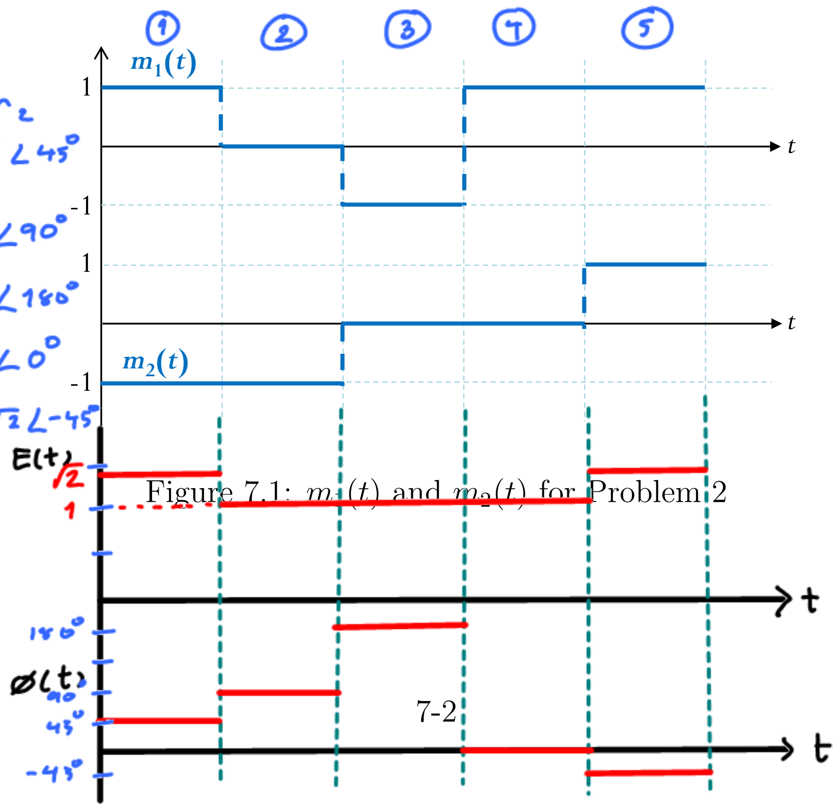

Figure 7.1: $m_1(t)$ and $m_2(t)$ for Problem 2