Name.....ID.....Section....1....Seat No.....

Sirindhorn International Institute of Technology
Thammasat University

Midterm Examination: Semester 1 / 2017

Course Title: ECS332 (Principles of Communications)

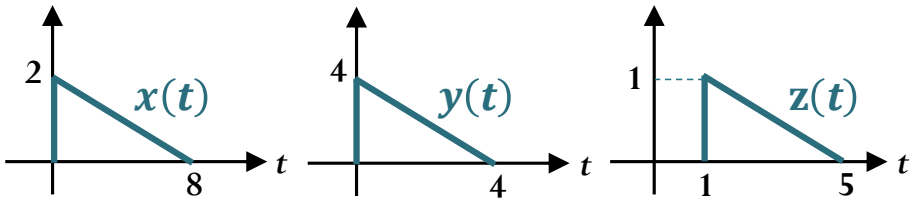
Instructor: Asst. Prof. Dr.Prapun Suksompong

Date/Time: October 4, 2017 / 12:00 - 14:00

Instructions:

- This examination has ...6... pages (including this cover page).
- Conditions of Examination:
  .....Closed book
  (No dictionary, ☐ No calculator ☑ Calculator (e.g. FX-991) allowed)
  .....Open book
  .....✓.....**Semi-Closed book** (.....1.....sheet(s) ☑ 1 page ☐ both sides of A4 paper note)
  This sheet must be hand-written.
  Do not modify (,e.g., add/underline/highlight) content on the sheet inside the exam room.
  It should be **submitted with the exam**.
  Other requirements are specified on the course web site. (-10 pt if not following the requirements.)
- **Read these instructions and the questions carefully**.
- Students are not allowed to be out of the examination room during examination.
  Going to the restroom may result in score deduction.
- Turn off all communication devices and place them with other personal belongings in the area designated by the proctors or outside the test room.
- Write your name, student ID, section, and seat number clearly in the spaces provided on the top of this sheet. Then, write your **first name and the last three digits of your ID** in the spaces provided on the top of each page of your examination paper, starting from page 2.
- The back of each page will not be graded; it can be used for calculations of problems that do not require explanation.
- The examination paper is not allowed to be taken out of the examination room. Also, do not remove the staple. Violation may result in score deduction.
- Unless instructed otherwise, ***write down all the steps*** that you have done to obtain your answers.
  - When applying formula(s), state clearly which formula(s) you are applying before plugging-in numerical values.
  - You may not get any credit even when your final answer is correct without showing how you get your answer.
  - Formula(s) not discussed in class can be used. However, derivation must also be provided.
  - **Exceptions**:
    - Problems that are labeled with "ENRPr" (Explanation is not required for this problem.)
    - Parts that are labeled with "ENRPa" (Explanation is not required for this part.)
    - These problems/parts are graded solely on your answers. There is no partial credit and it is not necessary to write down your explanation. Usually, spaces (boxes or cells in a table or rows of dashes) will be provided for your answers. "WACSP" stands for "write your answer(s) in the corresponding space(s) provided".
- When not explicitly stated/defined, all notations and definitions follow ones given in lecture.
  For example, the sinc function is defined by $\mathrm{sinc}(x) = (\sin x)/x$; time is denoted by t and frequency is denoted by f. The unit of t is in seconds and the unit of f is in Hz.
- Some points are reserved for *accuracy* of the answers and also for reducing answers into their *simplest* forms. Watch out for roundoff error.
- Points marked with * indicate challenging problems.
- Do not cheat. Do not panic. **Allocate your time wisely.**
- Don't forget to submit your fist online self-evaluation form by the end of today.

1. (6 pt) [ENRPr] Signals $x(t)$, $y(t)$, and $z(t)$ are plotted below.



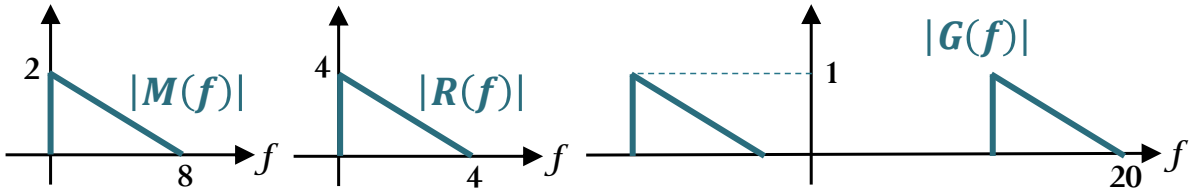
Suppose $y(t)=c_1x(c_2t+c_3)$ and $z(t)=c_4x(c_5t+c_6)$.

Find the values of the constants c_1, c_2, c_3, c_4, c_5, and c_6:

$c_1=$ _____, $c_2=$ _____, $c_3=$ _____, $c_4=$ _____, $c_5=$ _____, $c_6=$ _____ .

2. (4 pt) [ENRPr] Consider three signals $m(t)$, $r(t)$, and $g(t)$.

The magnitude plots of their Fourier transforms are shown below.

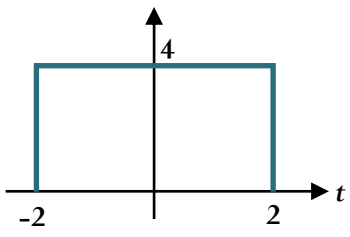
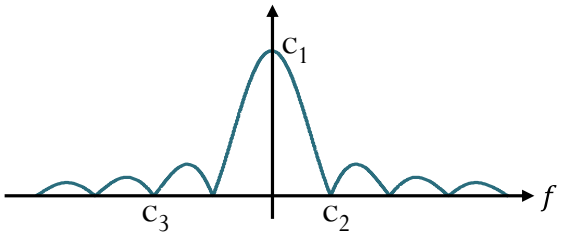
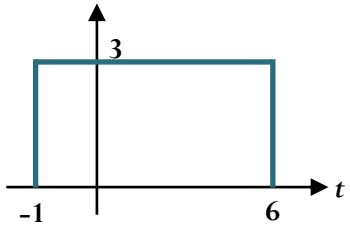
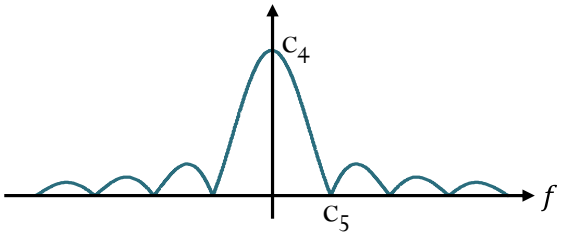


In the time domain, suppose $r(t)=c_1m\left(c_2t+\sqrt{\pi}\right)$ and $g(t)=c_3m(t)\cos(c_4t)$.

Find the values of the constants c_1, c_2, c_3, and c_4:

$c_1=$ _____, $c_2=$ _____, $c_3=$ _____, $c_4=$ _____.

3. (1+1+1+1+1 = 5 pt) [ENRPr] Each part below shows the plot of a signal and the corresponding magnitude plot of its Fourier transform. Find the values of the constants (corresponding to the zeroes and the peaks) shown in the plots.

	$x(t)$	$\lvert X(f)\rvert$
(a)		
(b)		

$c_1=$ _____, $c_2=$ _____, $c_3=$ _____, $c_4=$ _____, $c_5=$ _____.

4. (1+1+1+1 = 4 pt) [ENRPr] Consider a cosine pulse of the form

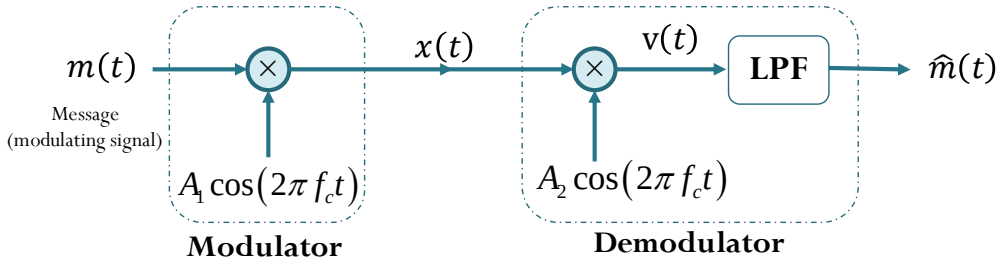
$$p(t)=\begin{cases} A\cos(2\pi f_0 t), & t_1 \le t \le t_2, \\ 0, & \text{otherwise.} \end{cases}$$

Suppose its Fourier transform is given by $P(f)=\text{sinc}(\pi f-\pi)+\text{sinc}(\pi f+\pi)$.

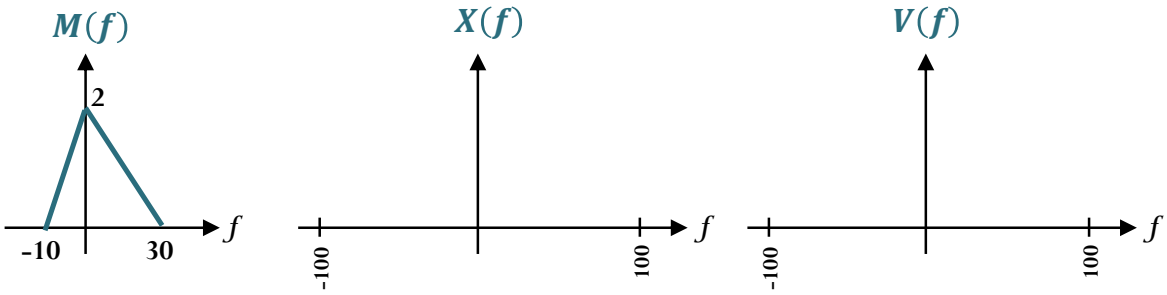
Find the values of the constants $f_0, t_1, t_2,$ and A:

$$f_0 = \_\_\_\_\_, t_1 = \_\_\_\_\_, t_2 = \_\_\_\_\_, A = \_\_\_\_\_.$$

5. (8 pt) [ENRPr] Consider the DSB-SC modem with no channel impairment shown below.



The Fourier transform of the message is plotted below.



Let $A_1 = 1, A_2 = 1$, and f_c = 30 Hz.

a. (3+4 = 7 pt) Plot $X(f)$ and $V(f)$ in the provided space above.

b. (1 pt) Suppose the low-pass filter (LPF) is ideal with frequency response

$$H_{LP}(f)=\begin{cases} g, & |f| \le 50 \\ 0, & \text{otherwise.} \end{cases}$$

Find the value of g that makes $\hat{m}(t)=m(t)$.

$$g = \_\_\_\_\_.$$

6. [ENRPr] (3+1** = 4 pt) Evaluate the following integrals:

a. $\int_{-\infty}^{\infty} \delta(t-3)dt = \_\_\_\_\_$

b. $\int_{-\infty}^{\infty} \delta(2t)dt = \_\_\_\_\_$

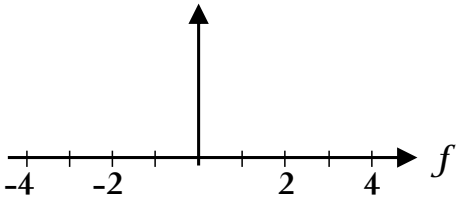
c. $\int_{3}^{5} \delta(t-4)e^{j10\pi t}dt = \_\_\_\_\_$

d. $\int_{-\infty}^{\infty} \delta(t^2-3t+2)dt = \_\_\_\_\_$

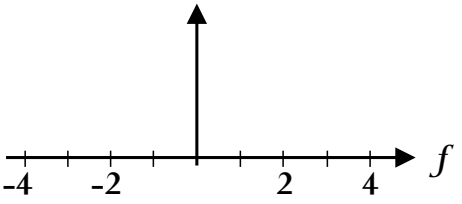
7. [ENRPr] (7 pt) Consider each $g(t)$ defined below.

Let $G(f)$ be its Fourier transform. Plot $|G(f)|$ from $f=-4$ to $f=4$ Hz.

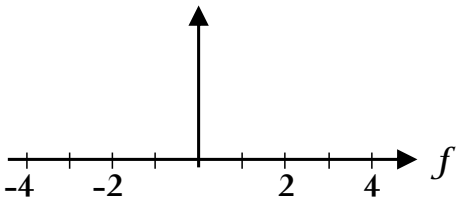
a. (2 pt) $g(t)=6e^{-j6\pi t}$



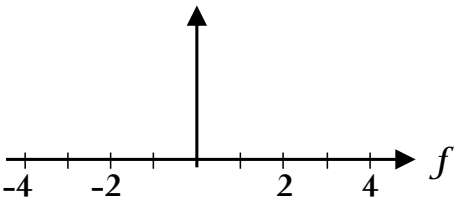
b. (3 pt) $g(t)=6\cos(6\pi t)$



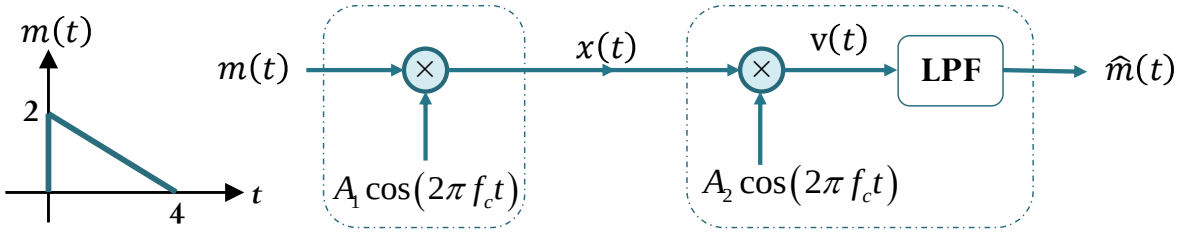
c. (1 pt) $g(t)=6\delta(t-6)$



d. (1* pt) $g(t)=\delta(t-6)+\delta(t-5)$



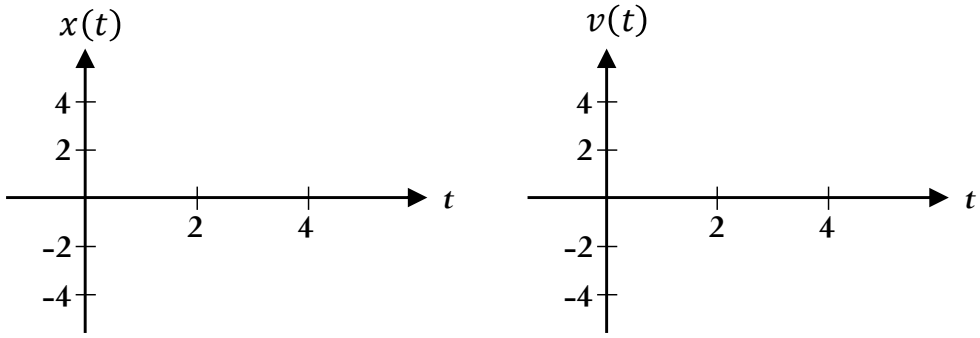
8. (6 pt) Consider the DSB-SC modem with no channel impairment shown below.



Note that the message itself is also plotted above.

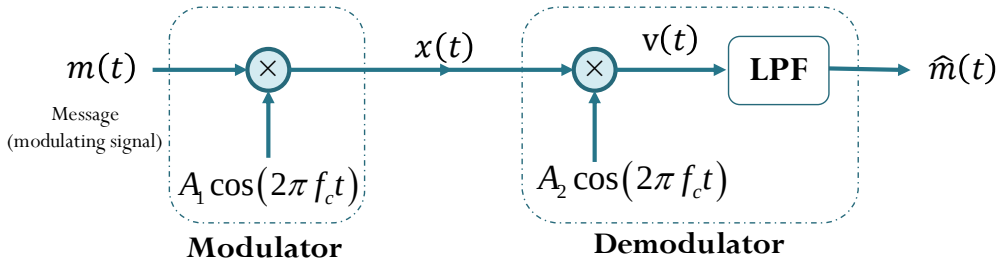
Let $A_1=1, A_2=1$, $f_c=1$ Hz, and $H_{LP}(f)=\begin{cases} g, & |f|\le 50, \\ 0, & \text{otherwise.} \end{cases}$

a. [ENRPa] (3+2 pt) Sketch $x(t)$ and $v(t)$ from time $t=0$ to time $t=4$.



b. (1* pt) Will $\hat{m}(t)=m(t)$? Don't forget to justify your answer.

9. (5+1* = 6 pt) [ENRPr] Consider the DSB-SC modem with no channel impairment shown below.



Let $A_1 = 1, A_2 = 1$, f_c = 2017 Hz, and $H_{LP}(f) = \begin{cases} 1, & |f| \le 777, \\ 0, & \text{otherwise.} \end{cases}$

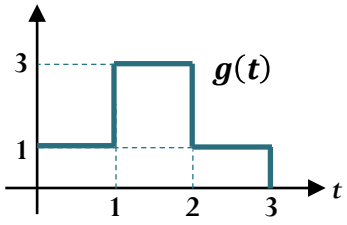
For each of the following $m(t)$, find the corresponding $\hat{m}(t)$.

$m(t)$	$\hat{m}(t)$
$m(t) = 4\cos(456\pi t)$	
$m(t) = 4\cos(3456\pi t)$	
$m(t) = 4\cos(6666\pi t)$	
$m(t) = 4\cos(8888\pi t)$	
$m(t) = 4\cos(12322\pi t)$	
$m(t) = 4\text{sinc}(1554\pi t)$	

10. (10 pt) [ENRPr] For each of the following signal $g(t)$, find its (normalized) average power $P_g \equiv \left\langle |g(t)|^2 \right\rangle$. Do not use any approximation.

$g(t)$	$P_g \equiv \left\langle |g(t)|^2 \right\rangle$
(1 pt) $g(t) = 30e^{j30\pi t}$	
(1 pt) $g(t) = 30e^{j30\pi t} + 40e^{j40\pi t}$	
(2 pt) $g(t) = 30\cos(30t + 30^\circ)$	
(2 pt) $g(t) = 30\cos(30t + 30^\circ) + 40\cos(40t + 40^\circ)$	
(2 pt) $g(t) = 50\cos(30t + 30^\circ) + 40\cos(30t + 120^\circ) + 20\cos(30t - 150^\circ)$	
(2 pt) $g(t) = 30e^{j30t} + 30\cos(30t)$	

11. (6 pt) Consider a signal $g(t)$ below.



Calculate the following quantities:

a. (1 pt) $\langle g(t) \rangle$

b. (3 pt) energy E_g

c. (1 pt) average power P_g

d. (1* pt) $\langle G(f), \text{sinc}(2\pi f) \rangle$ where $G(f)$ is the Fourier transform of $g(t)$

12. (1 pt)

a. (1 pt) Do not forget to submit your study sheet with your exam.
b. Reminder:
   i. Make sure that you write your name and ID on every page. (Read the instruction on the cover page.)
   ii. The online self-evaluation form is due by the end of today.