Exam 1 Information — 332: 345 — Fall 2004

Exam I will be based on the material from Chapters 1, 2, and 3 covered in class and outlined in the course syllabus.

Closed book and notes. No calculators allowed.

Tables 3.3 and 3.4 will be distributed to the students before the exam.

Study Guide: Do all homework problems and read the study guides given in chapter summaries.
No proofs of the Fourier transform properties.

Exam Time: Monday Oct 18, 2004; 8:10–9:30am (during regular class hours)

Place: SEC 111

Attachments:
Table 3.3
Table 3.4
Sample Exam I, Fall 2003

Point distribution for Exam 1: (35 points = 35% of the course grade)
Chapter 1: 5 points (5%)
Chapter 2: 10 points (10%)
Chapter 3: 20 points (20%)

ALL HOMEWORK SOLUTIONS ARE POSTED ON THE CLASS WEBCT.
HW#1 on Chapter 1
HW#2 on Chapter 2
HW#3 on Fourier Series and its use in System Analysis (response to periodic inputs)
HW#4 on Fourier Transform and its use in System Analysis (sinusoidal response)

MORE DETAILED SOLUTIONS TO HOMEWORK PROBLEMS FROM CH.APTER 1 WILL BE POSTED TODAY (10/11/2004)
(replacing the previously posted HW#1 solutions)

	Time	*Frequency*
1	$\alpha_1 x_1(t) \pm \alpha_2 x_2(t)$	$\alpha_1 X_1(j\omega) \pm \alpha_2 X_2(j\omega)$
2	$x(t-t_0)$	$e^{-j\omega t_0} X(j\omega)$
3	$x(at)$	$\frac{1}{\lvert a\rvert} X\left(\frac{j\omega}{a}\right)$
2&3	$x(at-t_0)$	$\frac{1}{\lvert a\rvert} e^{-j\left(\frac{\omega}{a}\right)t_0} X\left(\frac{j\omega}{a}\right)$
4	$t^n x(t)$	$(j)^n \frac{d^n}{d\omega^n} X(j\omega)$
5	$x(t)e^{j\omega_0 t}$	$X(j(\omega-\omega_0))$
6	$x(t)\cos(\omega_0 t)$ $x(t)\sin(\omega_0 t)$	$\frac{1}{2}[X(j(\omega+\omega_0)) + X(j(\omega-\omega_0))]$ $\frac{j}{2}[X(j(\omega+\omega_0)) - X(j(\omega-\omega_0))]$
7	$\frac{d^n}{dt^n} x(t)$	$(j\omega)^n X(j\omega)$
7a	$(-jt)^n x(t)$	$\frac{d^n X(j\omega)}{d\omega^n}$
8	$x_1(t) * x_2(t)$	$X_1(j\omega) X_2(j\omega)$
9	$x_1(t) x_2(t)$	$\frac{1}{2\pi} X_1(j\omega) * X_2(j\omega)$
10	$x(-t)$	$X(-j\omega)$
11	$X(jt)$	$2\pi x(-\omega)$
11a	$X(-jt)$	$2\pi x(\omega)$
12	$\int_{-\infty}^{t} x(\tau) d\tau$	$\frac{1}{j\omega} X(j\omega) + \pi X(j0)\delta(\omega)$
Parseval's Theorem	$\int_{-\infty}^{\infty} \lvert x(t)\rvert^2 dt$	$\frac{1}{2\pi} \int_{-\infty}^{\infty} \lvert X(j\omega)\rvert^2 d\omega$

Table 3.3: Properties of the Fourier transform

	Time	*Frequency*
1	$\delta(t)$	1
2	$e^{-at}u_h(t), \quad a > 0$	$\frac{1}{a+j\omega}$
3	$p_\tau^h(t)$	$\tau \mathrm{sinc}\left(\frac{\omega\tau}{2\pi}\right) = \tau \frac{\sin(\omega\tau/2)}{\omega\tau/2}$
4	$\Delta_\tau(t)$	$\frac{\tau}{2}\mathrm{sinc}^2\left(\frac{\omega\tau}{4\pi}\right)$
5	1	$2\pi\delta(\omega)$
6	const	$\mathrm{const} \times 2\pi\delta(\omega)$
7	$\cos(\omega_0 t)$	$\pi[\delta(\omega+\omega_0)+\delta(\omega-\omega_0)]$
8	$\sin(\omega_0 t)$	$j\pi[\delta(\omega+\omega_0)-\delta(\omega-\omega_0)]$
9	$\mathrm{sgn}(t)$	$\frac{2}{j\omega}$
10	$u_h(t)$	$\frac{1}{j\omega}+\pi\delta(\omega)$
11	$e^{-\alpha\|t\|}, \quad \alpha > 0$	$\frac{2\alpha}{\alpha^2+\omega^2}$
12	$e^{j\omega_0 t}$	$2\pi\delta(\omega-\omega_0)$
13	$\sum_{n=-\infty}^{\infty} X_n e^{jn\omega_0 t}, \quad \omega_0 = \frac{2\pi}{T}$	$2\pi \sum_{n=-\infty}^{\infty} X_n \delta(\omega - n\omega_0)$
14	$\sum_{n=-\infty}^{\infty} \delta(t-nT_0)$	$\omega_0 \sum_{n=-\infty}^{\infty} \delta(\omega-n\omega_0), \quad \omega_0 = \frac{2\pi}{T_0}$

Table 3.4: Common Fourier transform pairs

332:345 Linear Systems and Signals — Exam 1 — Fall 2003

#1) Consider the linear-time invariant system represented by

$$\frac{dy(t)}{dt} + 2y(t) = 3, \quad y(0) = 4$$

Find the system response and its zero-state and zero-input components. What are the response steady state and transient components.

#1b) Using the linearity and time invariance principle find the response of the system define din #1a) due to the input signal equal to $u(t) - u(t-2)$.

#2a) Using the properties of the impulse delta function simplify the following expressions

$$(i) \quad e^{-5t}\delta(t-2), \qquad (ii) \quad \int_{-\infty}^{\infty} (t+2)\delta(t-0.5)dt$$

$$(iii) \int_{-\infty}^{1} e^{-2t}\sin(\pi t)\delta^{(1)}(t-2)dt, \quad (iv) \int_{-5}^{5} e^{-5t}\cos(t-5)\delta(t-5)dt$$

#2b) Plot the graph of the signal represented in terms of unit step and unit ramp signals as

$$f(t) = u(-t+2) + u(t+2) + r(-t-1)$$

and find its generalized derivative.

#3a) Find the Fourier series of a periodic signal represented by

$$f(t) = f(t+2) = \begin{cases} 1, & -1 \le t \le 0 \\ 2, & 0 \le t \le 1 \end{cases}$$

#3b) Find the system response due to the periodic input signal given in #2a) of a linear system whose transfer function is $G(\omega) = \frac{1}{jw(1+j\omega)}$.

#3c) Using the tables of common pairs and properties of the Fourier transform find Fourier transforms of the following signals:

$$(i) \quad te^{-2|t|}, \quad (ii) \quad e^{-2t}u_h(t)\cos(t), \quad (iii) \int_{-\infty}^{t} p_2(3\tau)d\tau, \quad (iv)\ u_h(t-2)$$

#3d) Find the inverse Fourier transform of the signals

$$(i)\ \frac{1}{1+j\omega}\cos(2\omega)e^{-j5\omega} \qquad (ii)\ p_6(\omega-2)$$