Exam 2A
May 14, 2003

ECE 223: Signals and Systems II
Dr. McNames

• Write the first letter in your last name, your 6-digit identification number, and your student identification number below.
• Do not open the exam until instructed to do so.
• Do not use separate scratch paper. If you need more space, use the backs of the exam pages and write a note directing my attention to these pages.
• You will have 100 minutes to complete the exam.
• If you have extra time, double check your answers.
• Remember to include units with each of your answers.
• You are not allowed to use a calculator during this exam.

Problem 1:______ / 13
Problem 2:______ / 10
Problem 3:______ / 10
Problem 4:______ / 12

Total:______ / 45

First Letter in Last Name:_____________

6-Digit Identification Number:_____________

Student Identification Number:_____________
1. Fundamental Concepts (13 pts)

Circle the appropriate answers to the multiple choice questions below. The following abbreviations are used: FT = Fourier Transform, FS = Fourier Series, DT = Discrete-Time, and CT = Continuous-Time.

a. (2 pts) Which synthesis equations can recover all finite-power periodical signals exactly?

DTFT  DTFS  CTFT  CTFS

b. (1 pt) What is the magnitude of $x(t) = 7 \exp(-j200\pi t + 2\pi/3)$?

$|x(t)| = \underline{\quad \quad \quad \quad \quad \quad \quad \quad}$

c. (1 pt) What is the fundamental period of $x(t) = 65 \exp(-j250\pi t + 7\pi/3)$?

$T_o = \underline{\quad \quad \quad \quad \quad \quad \quad \quad}$

d. (1 pt) What type of symmetry does the CTFT of the following signal have: $x(t) = 65 \exp(-j250\pi t + 7\pi/3)$?

Even  Odd  Complex-Conjugate  None

e. (1 pt) Which of the following LTI systems have a different transfer function $H(j\omega)$ when it is calculated by the Fourier transform instead of the Laplace transform?

Causal  Non-causal  Memoryless

f. (2 pts) Which of the following transforms are periodic?

DTFT  DTFS  CTFT  CTFS

g. (2 pts) Which of the following transforms have complex-conjugate symmetry?

DTFT  DTFS  CTFT  CTFS

h. (1 pt) A signal $x(t)$ is recorded on audio tape. This signal has all of it’s energy equally distributed between 0 and 3 kHz. When the signal is played back at twice the speed, what fraction of the signal energy is located between 0 and 3 kHz?

$P = \underline{\quad \quad \quad \quad \quad \quad \quad \quad}$

i. (1 pt) What is an equivalent signal and simpler expression for $x[n] = \cos(6\pi n)$?

$x[n] = \underline{\quad \quad \quad \quad \quad \quad \quad \quad}$

j. (1 pt) If a discrete-time signal has finite power and infinite energy, which of the following is always present in the DTFT? (Circle only one)

Pair of Impulses  Impulse Train  No consistent feature
2. Matching Signals and Transforms (10 pts)

Ten discrete-time signals are shown in the left column of plots. Their transforms, shown in the right column of plots, were estimated by windowing 128 samples and applying the FFT with zero-padding. Enter the transform number corresponding to each signal in the spaces provided at the bottom of the page.

Signal A: _____  Signal B: _____  Signal C: _____  Signal D: _____  Signal E: _____
3. Continuous-Time Fourier Transforms (10 pts)

Use the signal and Fourier transforms plotted below to answer the following questions. Note that the real component of $Y(j\omega)$ is zero.

![Signal and Fourier Transform Diagram]

a. (1 pt) Does the Fourier transform of $x(t)$ exist technically? (Circle one)
   - Yes
   - No
   - Insufficient Information

b. (1 pt) Does the Fourier transform $Y(j\omega)$ exist technically? (Circle one)
   - Yes
   - No
   - Insufficient Information

c. (3 pts) Solve for the Fourier transform of $x(t)$. Simplify your answer as much as possible.

$$X(j\omega) =$$

d. (1 pt) How much energy does the signal $x(t)$ have?

$$W_x =$$

e. (3 pts) Solve for the signal $y(t)$. Simplify your answer as much as possible.

$$y(t) =$$

f. (1 pt) How much energy does the signal $y(t)$ have?

$$W_y =$$
4. Discrete-Time Fourier Transforms (12 pts)

Part of the magnitude squared and phase components of the transform of a real-valued discrete-time signal \( x[n] \) are shown below. Use these plots to answer the following questions.

- **a.** (4 pts) Use symmetry of the transform to draw the missing segments of these plots.
- **b.** (2 pts) What percentage of the signal energy is between the frequencies of 0 and \( \frac{\pi}{2} \)? Hint: use Parseval’s theorem.

\[
P = \text{________} \%
\]

- **c.** (1 pt) Is the signal periodic? (Circle one)
  - Yes
  - No
  - Insufficient Information

- **d.** (1 pt) Does the transform of \( x[n] \) converge? (Circle one)
  - Yes
  - No
  - Insufficient Information

- **e.** (2 pts) What is the transform of \( 0.2^n u[n-2] \)?

\[
X(e^{j\omega}) = \text{_______}
\]

- **f.** (2 pts) What is the transform of \( (n-1)(0.5)^n \) ?

\[
X(e^{j\omega}) = \text{_______}
\]