The Johns Hopkins University
Department of Electrical and Computer Engineering

505.460 — Introduction to Linear Systems — Fall 2002

Final exam

Name: ____

You are allowed to use:

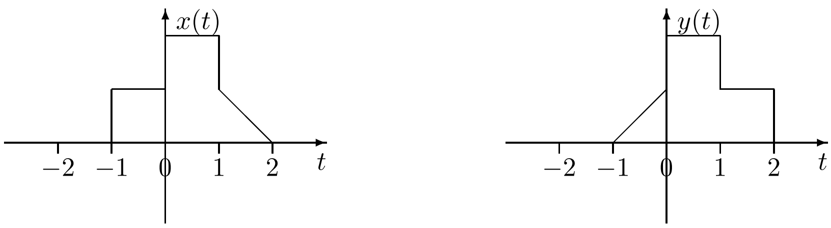
1. Table 3.1 (page 206) & Table 3.2 (page 221)
2. Table 4.1 (page 328) & Table 4.2 (page 329)
3. Table 5.1 (page 391) & Table 5.2 (page 392)
4. One standard size, double sided formula sheet.
5. Answer the questions in the sheet below.

1.	a	b	c	d	e
2.	a	b	c	d	e
3.	a	b	c	d	e
4.	a	b	c	d	e
5.	a	b	c	d	e
6.	a	b	c	d	e
7.	a	b	c	d	e
8.	a	b	c	d	e
9.	a	b	c	d	e
10.	a	b	c	d	e
11.	a	b	c	d	e
12.	a	b	c	d	e
13.	a	b	c	d	e
14.	a	b	c	d	e
15.	a	b	c	d	e
16.	a	b	c	d	e
17.	a	b	c	d	e
18.	a	b	c	d	e
19.	a	b	c	d	e
20.	a	b	c	d	e

1. Which of the following signals is equivalent to $x[n] = nu[n] - u[n-2]$?
   (a) $x[n] = \delta[n] + \delta[n-1]$
   (b) $x[n] = \delta[n] - \delta[n-2]$
   (c) $x[n] = \delta[n]$
   (d) $x[n] = \delta[n-1] + (n-2)u[n-2]$
   (e) None of the above.

2. Which of the following statements is not true?
   (a) $x(t) = e^{j2t/3}$ is continuous-time periodic.
   (b) $x[n] = e^{2t}u(-t)$ is bounded.
   (c) $x[n] = e^{j2n/3}$ is discrete-time periodic.
   (d) $x[n] = e^{jt} + e^{-jt}$ is periodic.
   (e) None of the above.

3. The signal $x(t)$ is shown below. Also shown is $y(t)$.



   The relationship between $y(t)$ and $x(t)$ is:
   (a) $y(t) = x(t-1)$
   (b) $y(t) = x(2-t)$
   (c) $y(t) = x(1-t)$
   (d) $y(t) = x(t-2)$
   (e) None of the above.

4. The system described by $y(t) = (x(t)x(t-2))u(t-1)$ is...
   (a) memoryless, time-invariant and linear.
   (b) time-invariant, linear and causal.
   (c) linear, causal and stable.
   (d) causal, stable and memoryless.
   (e) None of the above.

5. An LTI, discrete-time system has impulse response $h[n] = (5)^n\left(u[n-1] + u[1-n]\right)$; is the system
   (a) stable, but not causal?
   (b) causal, but not stable?
   (c) stable and causal?
   (d) not stable and not causal?
   (e) None of the above.

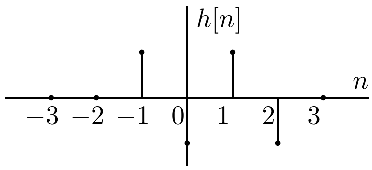
6. If $h[n] = \delta[n] + \delta[n-1]$ and $x[n] = nu[n] + \delta[n-2]$, then

   (a) $y[n] = nu[n] + nu[n-1] + \delta[n-1] + \delta[n-2]$
   (b) $y[n] = nu[n] + (n-1)u[n-2] + \delta[n-1] + \delta[n-2]$
   (c) $y[n] = nu[n] + (n-1)u[n-1] + \delta[n-2] + \delta[n-3]$
   (d) $y[n] = nu[n] + nu[n-2] + \delta[n-2] + \delta[n-3]$
   (e) None of the above.

7. For an LTI system with impulse response $h(t) = -\delta(t) + e^{-t}u(t)$ and input signal $x(t) = u(t)$, the value of the output signal at $t = 1$ is

   (a) $y(1) = 0$.
   (b) $y(1) = -\infty$.
   (c) $y(1) = 2 + 1/e$.
   (d) $y(1) = -1/e$.
   (e) None of the above.

8. For a discrete-time LTI system with impulse response $h[n] = nu[n]$ and input sketched below,



   the output signal $y[n]$ is zero on the range

   (a) $n \leq 0$, $n \geq 5$.
   (b) $n \leq -1$.
   (c) $n \geq 5$.
   (d) $n \leq -1$, $n \geq 5$.
   (e) None of the above.

9. The Fourier series representation of a function has non-zero coefficients $a_0 = 1$, $a_1 = a_{-1}^* = 2j$ and $a_3 = a_{-3} = 1$ and period $T_0 = 2$. The function $x(t)$ is

   (a) $2 - 2\cos(2\pi t) + 2\sin(6\pi t)$
   (b) $1 - 4\sin(2\pi t) + \sin(6\pi t)$
   (c) $2 + 2\cos(\pi t) + \cos(3\pi t)$
   (d) $1 - 4\sin(\pi t) + 2\cos(3\pi t)$
   (e) None of the above.

10. If $x(t) = 2\sin\left(\frac{2\pi}{3}t\right) + 4\cos\left(\frac{5\pi}{3}t\right)$, the fundamental period and Fourier series coefficients are

   (a) $T_0 = 6$, $a_2 = a_{-2}^* = -j$, $a_5 = a_{-5} = 2$
   (b) $T_0 = 3$, $a_1 = a_{-1}^* = -j$, $a_5 = a_{-5} = 4$
   (c) $T_0 = 3$, $a_2 = a_{-2}^* = -j$, $a_5 = a_{-5} = 2$
   (d) $T_0 = 6$, $a_1 = a_{-1}^* = -j$, $a_5 = a_{-5} = 2$
   (e) None of the above.

11. If the continuous-time periodic signal $x(t)$ has a Fourier series representation $x(t) = \sum_{k=-\infty}^{\infty} a_k e^{j\omega_0 kt}$ then the signal

$$y(t) = \frac{1}{3}x(t-1) + \frac{1}{3}x(t) + \frac{1}{3}x(t+1)$$

has Fourier series representation $y(t) = \sum_{k=-\infty}^{\infty} b_k e^{j\omega_0 kt}$ where

(a) $b_k = \frac{1}{3}a_{k-1} + \frac{1}{3}a_k + \frac{1}{3}a_{k+1}$
(b) $b_k = \frac{1}{3}(2\cos\omega_0 k + 1)a_k$
(c) $b_k = \frac{1}{3}a_{k-1}e^{-j\omega_0 t} + \frac{1}{3}a_k + \frac{1}{3}a_{k+1}e^{j\omega_0 t}$
(d) $b_k = a_{k-1}e^{-j\omega_0 t} + a_k + a_{k+1}e^{j\omega_0 t}$
(e) None of the above.

12. If $X(\omega)$ is the Fourier Transform of $x(t)$, and $z(t) = -3x\big(10(t-1)\big)$.

(a) $Z(j\omega) = \frac{3}{10}X(j\frac{\omega}{10})e^{j\omega}$
(b) $Z(j\omega) = -\frac{3}{10}X(j\frac{\omega}{10})e^{j\omega}$
(c) $Z(j\omega) = \frac{3}{20}X(j\frac{\omega}{5})e^{-j\omega}$
(d) $Z(j\omega) = -\frac{3}{20}X(j\frac{\omega}{5})e^{-j\omega}$
(e) None of the above.

13. If $x(t) = 4\sin t\cos t$

(a) $X(\omega)$ does not exist.
(b) $X(\omega) = 4\pi\delta(\omega) + 2\pi\delta(\omega-2) + 2\pi\delta(\omega+2)$.
(c) $X(\omega) = 4\pi\delta(\omega) + \frac{1}{2+j\omega} - \frac{1}{2-j\omega}$.
(d) $X(\omega) = 4\pi\delta(\omega-2) + 4\pi\delta(\omega+2)$.
(e) None of the above.

14. For the discrete-time function $x[n] = (\frac{1}{2})^{|n|}$, the discrete-time Fourier transform satisfies

(a) $\operatorname{Im} X(e^{j\omega}) = 0$.
(b) $\operatorname{Re} X(e^{j\omega}) = 0$.
(c) $\int_{-\pi}^{\pi} X(e^{j\omega})\,d\omega = 0$
(d) $X(e^{j0}) = 0$
(e) None of the above.

15. Ideal high pass filters can not be used in used in real-time applications because:

(a) They are too expensive.
(b) They require too much bandwidth.
(c) They can be made directly from low pass filters.
(d) They are not causal.
(e) None of the above.

16. Suppose that $h_{W_1}(t)$ represents the impulse response of an ideal low pass filter with cutoff W_1 Hz. Which of these reprents the impulse response of an ideal band-pass filter that passes signals with frequencies between 100 and 200 Hz?

    (a) $(\delta(t) - h_{100}(t)) * h_{200}(t)$
    (b) $(\delta(t) - h_{200}(t)) * h_{100}(t)$
    (c) $(1 - h_{200}(t)) * h_{100}(t)$
    (d) $(1 - h_{100}(t)) * h_{200}(t)$
    (e) None of the above.

17. For the signal

    $$x(t) = \sin(10\pi t) + 2\cos(20\pi t)$$

    the minimum sampling frequency that can be used to obtain samples of $x(t)$ without loss of information is

    (a) 10 Hz.
    (b) 10π Hz.
    (c) 20 Hz.
    (d) 40 Hz.
    (e) None of the above.

18. If the Nyquist frequency for $x_1(t)$ is ω_1 and the Nyquist frequency for $x_2(t)$ is ω_2, then the Nyquist frequency for the convolution of x_1 and x_2 is

    (a) $\max(\omega_1, \omega_2)$
    (b) $\min(\omega_1, \omega_2)$
    (c) $\omega_1 \times \omega_2$
    (d) $\omega_1 + w_2$
    (e) None of the above.

19. A DSB/SC modulation scheme

    (a) Sends a copy of the carrier.
    (b) Requires more bandwidth than a SSB scheme.
    (c) Is ideal for a situation where there is one sender and many receivers, such as commercial radio.
    (d) All of the above.
    (e) None of the above.

20. This teaching in this course has been...

    (a) Fascinating.
    (b) Scintillating.
    (c) Lucid.
    (d) The best I have ever seen.
    (e) All of the above.