Last Name: _____

First Name: _____

ID Number: _____

Lab day/time: _____

Lecture time: _____

I have neither given nor received aid on this examination, nor have I concealed any violation of the Honor Code.

Signature: _____

EECS 206 Exam 2, 2006-3-17
DO NOT TURN THIS PAGE OVER UNTIL TOLD TO BEGIN!

- This is a 50 minute in-class exam.
- It is closed book, closed notes, closed computer.
- You may use one 8.5x11" piece of paper, both sides, and a calculator.
- There are 20 problems for a total of 100 points. The questions are not necessarily in order of increasing difficulty.
- Do not spend too much time on one problem! If trouble, go on to another one. There is no partial credit.
- This exam has 4 pages. Make sure your copy is complete.
- Continuing to write *anything* after the ending time is announced will be considered an honor code violation.
  Fill out your name etc. above now, and do not wait until the end to circle your answers!
- Clearly circle your final answers on this copy of the exam, not elsewhere.

1. (5 points)
The system described by the input-output relationship $y[n] = \cos(2\pi\, x[n])$ is:
a) linear (L) and time-invariant (TI) b) L and not TI c) not L and TI d) not L and not TI e) insufficient information

2. (5 points)
The system described by the input-output relationship $y[n] = 4\, x[n] - \cos(\pi n)\, x[n-1]$ is:
a) linear (L) and time-invariant (TI) b) L and not TI c) not L and TI d) not L and not TI e) insufficient information

3. (5 points)
The system described by the input-output relationship $y[n] = 4\, x[n] + (n+1)\, x[n-1]$ is:
a) BIBO stable (S) and causal (C), b) S and not C, c) not S and C, d) not S and not C, e) insufficient information.

4. (5 points)
The LTI system having the impulse response $h[n] = \begin{cases} n+2, & n = 1, 4, 5 \\ 0, & \text{otherwise} \end{cases} = \{\underline{0}, 3, 0, 0, 6, 7\}$ is:
a) BIBO stable (S) and causal (C), b) S and not C, c) not S and C, d) not S and not C, e) insufficient information.

5. (5 points)
The fundamental period of the signal $y[n] = \cos\big(0.7\pi n + \frac{\pi}{4}\big)$ is:
a) 20/7 b) 10/7 c) 7 d) 10 e) 20 f) not periodic

6. (5 points)
The fundamental period of the signal $x[n] = 7\cos\big(0.7\pi n + \frac{\pi}{4}\big) + \cos\big(\frac{2}{15}\pi n\big)$ is:
a) 10 b) 15 c) 20 d) 60 e) 300 f) not periodic

7. (5 points)
The signal $x(t) = \cos(270\pi t)$ and which of the following signals become identical after sampling at 50 Hz:
a) 0 b) $\cos(\pi t)$ c) $\cos(30\pi t)$ d) $\cos(50\pi t)$ e) $\cos(60\pi t)$ f) $\cos(100\pi t)$

8. (5 points)
The analog signal $x(t) = \cos(270\pi t) + \sin(50\pi t)$ is sampled at 50 Hz. The sampled signal is then interpolated by an *ideal* D-A converter. The result is:
a) 0 b) $\cos(\pi t)$ c) $\cos(30\pi t)$ d) $2\cos(30\pi t)$ e) $\sqrt{2}\cos(60\pi t)$ f) $\sqrt{2}\cos(30\pi t)$

9. (5 points)
We wish to sample the following signal without aliasing: $x(t) = \cos(2\pi 100t)\sin(2\pi 50t)$.
Which of the following sampling frequencies is the smallest frequency that will be satisfactory?
a) 51 Hz b) 101 Hz c) 151 Hz d) 201 Hz e) 251 Hz f) 301 Hz

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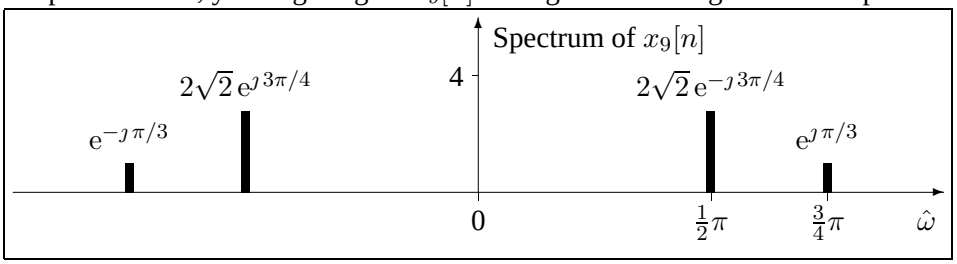
10. (5 points)
A signal $x(t)$ is sampled at 40Hz, yielding a signal $x_9[n]$ having the following two-sided spectrum.



Which of the following signals could have been $x(t)$?
a) $4\sqrt{2}\cos(10t - 3\pi/4) + 2\cos(15t + \pi/3)$
b) $4\sqrt{2}\cos(10t) + 2\cos(15t)$
c) $4\sqrt{2}\cos(10\pi t - 3\pi/4) + 2\cos(15\pi t + \pi/3)$
d) $4\sqrt{2}\cos(20\pi t) + 2\cos(30\pi t)$
e) $4\sqrt{2}\cos(60\pi t - 3\pi/4) + \cos(30\pi t + \pi/3)$
f) $4\sqrt{2}\cos(100\pi t - 3\pi/4) + 2\cos(30\pi t + \pi/3)$

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11. (5 points)
The signal $x_9[n]$ whose spectrum is shown above is passed through an ideal filter that removes all frequency components having frequencies below $\hat{\omega}_c = 5\pi/8$. Determine the mean-squared value of the signal at the output of the filter.
a) 0 b) 1 c) 2 d) 3 e) 4 f) 5

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12. (5 points)
The value of the line spectrum of the signal $\sin(\pi n) + 2\cos\left(\frac{4}{3}\pi n\right)$ at $\hat{\omega} = \frac{2}{3}\pi$ is:
a) 0 b) 1 c) 2 d) 3 e) 4 f) 5

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13. (5 points)
The 4-point DFT of the signal $\{\underline{4}, 8, 8, 8\}$ is:
a) $\{\underline{28}, -4, -4, -4\}$ b) $\{\underline{28}, 4, -4, 4\}$ c) $\{\underline{28}, -4, 4, -4\}$ d) $\{\underline{7}, -1, -1, -1\}$ e) $\{\underline{7}, 1, -1, 1\}$ f) $\{\underline{7}, -1, 1, -1\}$

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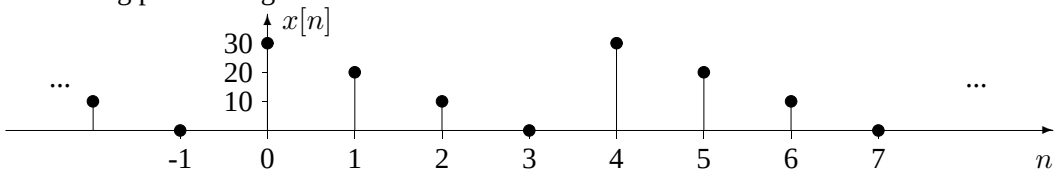
14. (5 points)
The signal $x[n]$ is periodic with $x[n] = \begin{cases} 3, & n = \ldots, -3, 0, 3, 6, \ldots \\ 6, & \text{otherwise.} \end{cases}$
Which of the following is a correct expression for $x[n]$?
a) $2 + 5\cos\left(\frac{2\pi}{3}n\right)$
b) $2 + 5\cos\left(\frac{\pi}{3}n\right)$
c) $2 - 5\cos\left(\frac{\pi}{3}n\right)$
d) $5 - \cos\left(\frac{2\pi}{3}n\right)$
e) $5 - 2\cos\left(\frac{2\pi}{3}n\right)$
f) $5 + 2\cos\left(\frac{2\pi}{3}n\right)$

15. (5 points)
Consider the following periodic signal.



This signal can be written as $x[n] = A + B\,\mathrm{e}^{\jmath\frac{\pi}{2}n} + C\,\mathrm{e}^{\jmath\pi n} + D\,\mathrm{e}^{\jmath\frac{3\pi}{2}n}$. Determine the value of D.
a) $20\,\mathrm{e}^{\jmath\pi/4}$ b) $20\sqrt{2}\,\mathrm{e}^{\jmath\pi/4}$ c) $5+\jmath$ d) $5-\jmath$ e) $5\,\mathrm{e}^{\jmath\pi/4}$ f) $5\sqrt{2}\,\mathrm{e}^{\jmath\pi/4}$

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16. (5 points)
The DFT of a signal $x[n]$ with period 6 is given by $\{\underline{1}, 0, 1-\jmath, 2, 1+\jmath, 0\}$. Determine the average power of $x[n]$.
a) $1/6$ b) 1 c) 4 d) 5 e) 7 f) 9

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17. (5 points)
The response of the system described by $y[n] = x[n] + x[n-2]$ to the input $x[n] = \{\underline{1}, 2\}$ is:
a) $\{\underline{1}, 2, 1, 2\}$ b) $\{\underline{1}, 2, 2, 4\}$ c) $\{\underline{1}, 3, 2, 0\}$ d) $\{\underline{2}, 4, 1, 2\}$ e) $\{\underline{2}, 1, 2, 1\}$ f) $\{\underline{2}, 4, 2, 4\}$

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18. (5 points)
An LTI system having impulse response $h_1[n] = \{\underline{1}, 0, 1\}$ is connected in *series* with an LTI system having impulse response $h_2[n] = \delta[n] + 2\,\delta[n-1]$, as follows:

$$x[n] \rightarrow \boxed{h_1[n]} \rightarrow \boxed{h_2[n]} \rightarrow y[n]\,.$$

The overall system is all of the following except:
a) FIR b) IIR c) Causal d) BIBO Stable e) Linear f) Time invariant

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19. (5 points)
An LTI system having impulse response $h_1[n] = \{\underline{1}, 0, 1\}$ is connected in *series* with an LTI system having impulse response $h_2[n] = \delta[n] + 2\,\delta[n-1]$. Determine the overall impulse response $h[n]$ of this cascade.
a) $\{\underline{1}, 2, 1, 2\}$ b) $\{\underline{1}, 2, 2, 4\}$ c) $\{\underline{1}, 3, 2, 0\}$ d) $\{\underline{2}, 4, 1, 2\}$ e) $\{\underline{2}, 1, 2, 1\}$ f) $\{\underline{2}, 4, 2, 4\}$

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20. (5 points)
The signal $x[n] = \cos(\pi n)$ is the input to a LTI system having impulse response $h[n] = \{\underline{1}, 0, 1\}$.
Determine the output signal.
a) 0 b) $\frac{1}{2}\cos(\pi n)$ c) $\cos(\pi n)$ d) $2\cos(\pi n)$ e) 1 f) 2

end