ECE 3300 Exam Solutions

Modified May 7, 2017

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Answers: CDDD ACDD ADBB

(An error was made on Problem 4; the intended question was to find the power for $x[n] = n(u[n+3] - u[n-3])$. The answer of A on Problem 4 was also accepted.)

Serial Number: **101** Name:

ECE 3300 Fall 2015 (Signals, Systems, and Transforms): Exam 1

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Question 1: The *average energy* of two signals $x(t)$ and $y(t)$ is defined as $\frac{1}{2}(E_x + E_y)$. Determine the average energy of $x(t)$ and $y(t)$ if $R_{x,y} = 3$ and $\text{MSE}_{x,y} = 2$. Choose the closest answer.
A: 1.
B: 3.
C: 4.
D: 5.
E: 2.

Question 2: Consider the complex-valued signal $x(t) = 2e^{jt} + e^{-jt}$. Determine $|x(t)|$. The answer can be written in the form $\sqrt{1 + a\cos^2(t)}$. What is a? Choose the closest answer.
A: 6.
B: 4.
C: 10.
D: 8.
E: 2.

Question 3: Suppose $x[n] = 1$ at times $n = 1$, 3, 4, and 7, $x[n] = -1$ at times $n = 2$, 5, and 6, and $x[n] = 0$ at all other times. Suppose $y[n] = x[n] - x[n-1]$. Let A be the number of points in time that $y[n]$ equals -2 and B the number of points in time that $y[n] = -1$. What is $A + B$? Choose the closest answer.
A: 1.
B: 4.
C: 2.
D: 3.
E: 5.

Question 4: Suppose $\tilde{x}[n]$ is periodic with fundamental period $N_0 = 6$ and fundamental cycle $x[n] = n^2(u[n+3] - u[n-3])$. Determine the power $P_{\tilde{x}}$. Choose the closest answer.
A: 3.
B: 1.
C: 4.
D: 5.
E: 2.

Question 5: Determine the fundamental period of $x(t) = \cos(255\pi t) + \cos(340\pi t)$. Choose the closest answer. *Hint:* It is equal to the LCM of the fundamental periods of the two cosines.
A: 0.025.
B: 0.015.
C: 0.005.
D: 0.01.
E: 0.02.

Question 6: Suppose $x(t) = t(u(t) - u(t-1))$ and $y(t) = (u(t) - u(t-1))$. Determine the correlation coefficient $\rho_{x,y}$. The answer can be written as $\sqrt{n}/m$ where n and m are positive integers and the fraction is as simplified as possible. What is $n + m$? Choose the closest answer.
A: 11.
B: 7.
C: 5.
D: 9.
E: 13.

Question 7: Suppose $x[n] = (n+3)(n-2)(u[n+2] - u[n-3])$. Determine $y[n] = \text{Od}\{x[n]\}$. What is $y[0] + y[1] + y[2]$? Choose the closest answer.
A: 1.
B: 2.
C: 5.
D: 3.
E: 4.

Question 8: Simplify $\int_t^{\infty} \sin(\frac{\pi}{2}\tau)\delta(\tau+1)d\tau$.
A: $-u(-1+t)$.
B: $u(-1+t)$.
C: $u(-1-t)$.
D: $-u(-1-t)$.
E: 0.

Question 9: Suppose $\tilde{x}[n]$ is periodic with fundamental period $N_0 = 3$ and fundamental cycle $x[n] = \delta[n+1]+2\delta[n]+2\delta[n-1]$. Suppose $\tilde{y}[n]$ is the periodic sum signal for $\tilde{x}[n]$. What is $\tilde{y}[16]$? Choose the closest answer. *Hint:* The periodic sum signal is periodic with period N_0. Thus $\tilde{y}[16] = \tilde{y}[16 - N_0] = \tilde{y}[16 - 2N_0]$ etc. If you keep shifting back you will eventually be in the time region of the fundamental cycle $y[n]$.
A: 5.
B: 3.
C: 1.
D: 2.
E: 4.

Question 10: Suppose $x(t)$ has turn-on time $t = -5$ and turn-off time $t = -2$. Suppose $y(t) = x(-t) + x(t-2)$. What is the time duration of $y(t)$? Choose the closest answer. *Hint:* The time duration is the duration of time between turn-on and turn-off times; if the signal equals zero in intermediate points in time, the time duration is unaffected.
A: 10.
B: 6.
C: 9.
D: 8.
E: 7.

Question 11: Suppose $x(t) = t^2(u(t+1) - u(t-2)) + t(u(t-2) - u(t-3))$. Determine the derivative signal $y(t) = \frac{d}{dt}x(t)$. The answer has the form $A\delta(t+1) + Bt(u(t+1) - u(t-2)) + C\delta(t-2) + D(u(t-2) - u(t-3)) + E\delta(t-3)$. What is $A + B + C + D + E$? Choose the closest answer.
A: 1.
B: -1.
C: 0.
D: 2.
E: -2.

Question 12: Suppose $x(t) = (2t-1)(u(t+3) - u(t-1))$ and $y(t) = x(2t)$. The signal $y(t)$ can be written as $y(t) = (At + B)(u(t-C) - u(t-D))$, where $D > C$. What is $A + B + C + D$? Choose the closest answer.
A: 3.
B: 2.
C: 1.
D: 5.
E: 4.

Answers: 101 AAAE DDEB CCCB

(If your test is not 101, match up your questions and answers with this test.)

Serial Number: **101** Name:

ECE 3300 Fall 2016 (Signals, Systems, and Transforms): Exam 1

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Question 1: Suppose $x[n] = 4(2)^n(u[n+2] - u[n-2]) + \delta[n-2]$. Determine $y[n] = \text{Ev}\{x[n]\}$. What is $y[0]$? $y[1]$? $y[2]$? Determine the sum of these values. Choose the closest answer.
A: 10.
B: 8.
C: 6.
D: 9.
E: 7.

Question 2: Simplify $\int_{t-4}^{t-1} (2-\tau)\delta(\tau-1)d\tau$. The answer can be written in the form $A(u(t-B) - u(t-C))$. What is $A+B+C$? Choose the closest answer.
A: 8.
B: 4.
C: 2.
D: 6.
E: 10.

Question 3: Suppose $\tilde{x}(t)$ is periodic with fundamental period $T_0 = \frac{9}{2}$ and fundamental cycle $x(t) = \sqrt{t+1}(u(t+1)-u(t-2))$. Determine the power $P_{\tilde{x}}$. Choose the closest answer.
A: 1.0.
B: 0.6.
C: 0.8.
D: 0.2.
E: 0.4.

Question 4: Suppose $x[n] = 3\delta[n+3]-\delta[n+2]+2\delta[n+1]-\delta[n]+u[n-1]$. Consider the summation signal $y[n] = \sum_{m=-\infty}^{n} x[m]$. At what time value n does $y[n] = 5$? Choose the closest answer.
A: 5.
B: 4.
C: 3.
D: 1.
E: 2.

Question 5: Consider the sum of two signals with fundamental periods $T_1 = \frac{3}{8}\pi$ and $T_2 = \frac{9}{16}\pi$. If the sum of the signals has fundamental period $T = \text{LCM}(T_1, T_2)$, what is T? Choose the closest answer.
A: 6.5.
B: 5.5.
C: 7.5.
D: 3.5.
E: 4.5.

Question 6: Suppose $x[n] = u[n+3] - u[n+2] + n^2(u[n] - u[n-3])$. Determine the time duration. Choose the closest answer.
A: 4.
B: Infinite.
C: 7.
D: 6.
E: 5.

Question 7: Suppose $x[n] = (5-n)(u[n-1] - u[n-5])$ and $y[n] = x[n-1]$. Determine the mean-squared error $\text{MSE}_{x,y}$. Choose the closest answer.
A: 25.
B: 10.
C: 30.
D: 15.
E: 20.

Question 8: Suppose $x(t) = 2\delta(t) - 2(u(t-2) - u(t-5)) + \delta(t-3)$ and suppose $y(t) = \int_{-\infty}^{t} x(\tau)d\tau$. What is $y(1)$? $y(2)$? $y(4)$? Determine the sum of these three values. Choose the closest answer.
A: 1.
B: 3.
C: 5.
D: 2.
E: 4.

Question 9: Consider the complex-valued signal $x[n] = (n+1)(u[n] - u[n-3]) - 4j(u[n-2] - u[n-4])$. Determine $|x[n]|$. The answer can be written in the form $A\delta[n] + B\delta[n-1] + C\delta[n-2] + D\delta[n-3] + E\delta[n-4]$. What is $A+B+C+D+E$? Choose the closest answer.
A: 14.
B: 13.
C: 12.
D: 11.
E: 10.

Question 10: Suppose $x[n] = (\cos(\frac{\pi}{2}n) + \sin(\frac{\pi}{2}n)(u[n] - u[n-5])$. Determine the difference signal $y[n] = x[n] - x[n-1]$. What is $y[3]$? $y[4]$? Determine the sum of these values. Choose the closest answer.
A: 0.
B: -2.
C: 2.
D: -1.
E: 1.

Question 11: Consider the periodic signal $\tilde{x}(t)$ with fundamental period $T_0 = 4$ and fundamental cycle $x(t) = (t+1)(u(t+2) - u(t)) + 2(u(t) - u(t-2))$. Suppose $\tilde{y}(t) = \frac{d}{dt}\tilde{x}(t)$. Determine the fundamental cycle $y(t)$. The answer has the form $A\delta(t+2) + B(u(t+2) - u(t)) + C\delta(t) + D(u(t) - u(t-2))$. What is $A + B + C + D$? Choose the closest answer.
A: 2.
B: 1.
C: -1.
D: 0.
E: -2.

Question 12: Suppose $x(t) = (t+1)(u(t-1) - u(t-3)) + (6-t)(u(t-4) - u(t-6))$ and $y(t) = x(4-2t)$. At what time does $y(t)$ equal 3? At what time does $y(t) = 1$? Determine the sum of these time values. Choose the closest answer.
A: 1.5.
B: 0.5.
C: 4.5.
D: 3.5.
E: 2.5.

Answers: 101 DCDE BDAC CCAD

Serial Number: **101** Name:

ECE 3300 Spring 2016 (Signals, Systems, and Transforms): Exam 1

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Question 1: Suppose $x(t) = (u(t+2) - u(t-2)) - \delta(t+1) - 2\delta(t) - \delta(t-3)$. Suppose $y(t) = \int_{-\infty}^{t} x(\tau)d\tau$. Determine $y(1)$, $y(2)$, and $y(4)$. What is the sum of these three values? Choose the closest answer.
A: 4.
B: 5.
C: 3.
D: 1.
E: 2.

Question 2: Suppose $x[n] = (n^2 + n)(u[n+2] - u[n-2])$ and $y[n] = 2x[n-1]$. What is $y[-1] + y[1] + y[3]$? Choose the closest answer.
A: 12.
B: 10.
C: 4.
D: 6.
E: 8.

Question 3: Suppose $x(t) = 3t(u(t) - u(t-2))$ and $y(t) = 2(t-1)(u(t+1) - u(t-1))$. Determine the correlation $R_{x,y}$. Choose the closest answer.
A: -3.
B: -4.
C: -5.
D: -1.
E: -2.

Question 4: Suppose $x[n] = (n-2)^2(u[n] - u[n-4])$. Determine the difference signal $y[n] = x[n] - x[n-1]$. What is $y[0]$? $y[2]$? $y[4]$? Determine the sum of these values. Choose the closest answer.
A: 4.
B: 1.
C: 3.
D: 0.
E: 2.

Question 5: Suppose the periodic signals $\tilde{x}[n]$ and $\tilde{y}[n]$ each have fundamental period $N_0 = 5$ and fundamental cycles $x[n]$ and $y[n]$. Suppose these fundamental cycles have energy $E_x = 5$ and $E_y = 6$ and correlation $R_{x,y} = 3$. Determine the mean-square error of the periodic signals, $\text{MSE}_{\tilde{x},\tilde{y}}$. Choose the closest answer.
A: 2.
B: 1.
C: 5.
D: 3.
E: 4.

Question 6: Suppose $x(t)$ has turn-on time $t = 1$ and turn-off time $t = 3$. Suppose $y(t) = x(t+3) + x(3t)$. What is the time duration of $y(t)$? Choose the closest answer. *Hint:* The time duration is the duration of time between turn-on and turn-off times; if the signal equals zero in intermediate points in time, the time duration is unaffected.
A: 5.
B: 7.
C: 11.
D: 3.
E: 9.

Question 7: Suppose $x(t) = 1$ if $0 < t \leq 1$, $2t$ if $1 < t \leq 2$, 0 if $t \leq 0$, and 2 if $t > 2$. Determine $y(t) = \frac{d}{dt}x(t)$. The answer has the form $A(u(t) - u(t-1)) + B(u(t-1) - u(t-2)) + C\delta(t) + D\delta(t-1) + E\delta(t-2)$. What is $A + B + C + D + E$? Choose the closest answer.
A: 2.
B: 1.
C: 0.
D: 3.
E: 4.

Question 8: Consider the complex-valued signal $x(t) = \frac{2}{2+e^{jt}}$. Determine $\text{Re}\{x(t)\}$. The answer can be written in the form $\frac{4+A\cos(t)}{B+C\cos(t)}$. What is $A + B + C$? Choose the closest answer.*Hint:* Use $\text{Re}\{x(t)\} = \frac{1}{2}x(t) + \frac{1}{2}x^*(t)$ and put the result over a common denominator.
A: 3.
B: 7.
C: 11.
D: 9.
E: 5.

Question 9: Simplify $\sum_{m=n-3}^{4} (\frac{1}{2})^m \delta[m+1]$. The answer has the form $Au[B + Cn]$, where $C = 1$ or -1. What is $A + B + C$? Choose the closest answer.
A: 7.
B: 6.
C: 3.
D: 5.
E: 4.

Question 10: Suppose $\tilde{x}(t)$ is periodic with fundamental period $T_0 = 2$ and fundamental cycle $x(t) = t^2(u(t+1) - u(t-1))$. Determine the power $P_{\tilde{x}}$. Choose the closest answer.
A: 0.6.
B: 1.0.
C: 0.2.
D: 0.8.
E: 0.4.

Question 11: Suppose $x(t) = (t+2)(u(t+1) - u(t-2))$. Determine $y(t) = \text{Ev}\{x(t)\}$. Let $y(1^+)$ denote the value of $y(t)$ just to the right of $t = 1$, and let $y(1^-)$ denote the value of $y(t)$ just to the left of $t = 1$. What is $y(1^+) + y(1^-)$? Choose the closest answer.
A: 3.5.
B: 1.5.
C: 2.5.
D: 5.5.
E: 4.5.

Question 12: Two signals with fundamental periods $T_1 = 4.84$ and $T_2 = 2.64$. If the sum of the signals has fundamental period $T = \text{LCM}(T_1, T_2)$, what is T? Choose the closest answer.
A: 12.
B: 24.
C: 18.
D: 30.
E: 6.

Test 101 Answers: BEAB ABAA CAEC

Serial Number: **101** Name:

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Question 1: Suppose $x(t) = t(u(t) - u(t-4))$ and $y(t) = (u(t-2) - u(t-6))$. Determine the correlation coefficient $\rho_{x,y}$. Choose the closest answer.
A: 0.55.
B: 0.65.
C: 0.75.
D: 0.85.
E: 0.95.

Question 2: Consider the periodic signal $\tilde{x}[n]$ with fundamental period $N_0 = 8$ and fundamental cycle $x[n] = n(-1)^n$ if $-3 \leq n \leq 0$ and 0 otherwise. Determine the corresponding periodic summation signal $\tilde{y}[n]$. What is $\tilde{y}[2]$? Choose the closest answer.
A: 0.
B: -2.
C: 1.
D: -1.
E: 2.

Question 3: Let N_1 be the fundamental period of $\tilde{x}[n] = \cos(\frac{5\pi}{12}n)$ and N_2 the fundamental period of $\tilde{y}[n] = \cos(\frac{5\pi}{9}n)$. The sum $x[n] + y[n]$ has fundamental period $N = \text{LCM}\{N_1, N_2\}$. Determine N. Choose the closest answer.
A: 72.
B: 18.
C: 90.
D: 54.
E: 36.

Question 4: Suppose $x[n] = (2^n - n)(u[n] - u[n-4])$. Determine the difference signal $y[n] = x[n] - x[n-1]$. What is $y[0]$? $y[1]$? $y[3]$? Determine the sum of these values. Choose the closest answer.
A: 5.
B: 4.
C: 1.
D: 3.
E: 2.

Question 5: Consider the complex-valued signal $x(t) = (2 + jt)e^{jt}$. Determine $\text{Re}\{x(t)\}$. The answer can be written in the form $(A + Bt)\cos(t) + (C + Dt)\sin(t)$. Determine $A + B + C + D$. Choose the closest answer.
A: 1.
B: 5.
C: 4.
D: 2.
E: 3.

Question 6: Suppose $x[n] = (-1 - n)(u[n-1] - u[n-3]) + (n-2)(u[n-4] - u[n-6])$ and $y[n] = |x[n]|$. Determine the maximum value of $y[n]$. Choose the closest answer.
A: 4.
B: 3.
C: 1.
D: 2.
E: 5.

Question 7: Simplify $\int_{-1}^{2} \tau\delta(\tau - t - 1)d\tau$. The answer can be written in the form $(t + A)(u(t - B) - u(t - C))$. What is $A + B + C$? Choose the closest answer.
A: 0.
B: 2.
C: -2.
D: 1.
E: -1.

Question 8: Suppose $x(t) = 2t(u(t) - u(t - 1)) + t(u(t - 1) - u(t - 2)) + u(t - 2)$. The derivative signal $y(t) = \frac{d}{dt}x(t)$ has the form $A(u(t) - u(t - 1)) + B(u(t - 1) - u(t - 2)) + C\delta(t) + D\delta(t - 1) + E\delta(t - 2)$. Determine $A + B + C + D + E$. Choose the closest answer.
A: 1.
B: 3.
C: 4.
D: 5.
E: 2.

Question 9: Suppose $\tilde{x}[n]$ is periodic with fundamental period $N_0 = 7$ and fundamental cycle $x[n] = n/3$, $-3 \leq n \leq 3$ and 0 otherwise. Determine the power $P_{\tilde{x}}$. Choose the closest answer.
A: 0.15.
B: 0.55.
C: 0.45.
D: 0.25.
E: 0.35.

Question 10: Suppose $x(t) = t(u(t) - u(t - 2)) - \delta(t + 1) + \delta(t - 1)$ and suppose $y(t) = \int_{-\infty}^{t} x(\tau)d\tau$. What is $y(0)$? $y(2)$? $y(4)$? Determine the sum of these three values. Choose the closest answer.
A: 3.
B: 2.
C: 5.
D: 1.
E: 4.

Question 11: Suppose $x[n] = 4\delta[n+3] - 2\delta[n+2] + \delta[n] + 2\delta[n-2] - 2\delta[n-3]$. Determine $y[n] = \text{Od}\{x[n]\}$. What is $y[0]$? $y[2]$? $y[-3]$? Determine the sum of these values. Choose the closest answer.
A: 4.
B: 1.
C: 3.
D: 2.
E: 5.

Question 12: Suppose $x(t) = (u(t+2) - u(t+1)) + (u(t-1) - u(t-4))$ and $y(t) = x(2-2t)$. Let t_{on} and t_{off} be the turn-on and turn-off times for $y(t)$. What is the sum of these two values? Choose the closest answer.
A: 2.
B: 3.
C: 1.
D: 5.
E: 4.

Test 201 Answers: BDAC EECD DBDA

Serial Number: **201** Name:

ECE 3300 Fall 2015 (Signals, Systems, and Transforms): Exam II

Record your name on this test; record your name, student ID, and test serial number on the scantron. Enter the test serial number in *COURSE*; you may leave *SECTION* blank. You must show your work on every problem, showing all steps on your test. Do not use scratch paper or write your work anywhere but on the test. The examination lasts 50 minutes and you may use two sheets of notes (front and back); no old test questions can be on your notes. Calculator use is permitted. There is one correct answer per question.

Question 1: Consider the system $y[n] = \cos(x[n+1] - x[n-1])$. This system is
A: Time-varying because the output due to $x[n] = (-1)^n u[n]$ is not a delay by 1 of the output due to $x[n] = (-1)^n u[n-1]$.
B: Time-invariant because, for all inputs $x[\cdot]$ and all values n_0, the output due to $x[\cdot - n_0]$ is a delay by n_0 of the output due to $x[\cdot]$.
C: Time-invariant because the output due to $x[n] = (-1)^n$ is does not vary over time (it is a constant).
D: Time-varying because the output due to $x[n] = (-1)^n u[n]$ is not a delay by 1 of the output due to $x[n] = (-1)^{n-1} u[n-1]$.
E: Time-invariant because the output due to $x[n] = (-1)^n u[n]$ is a delay by two of the output due to $x[n] = (-1)^{n-2} u[n-2]$.

Question 2: Consider the system with input $x[\cdot]$ and output $y[\cdot]$ such that $y[n] = n^2 x[0] - x[n]$. This system is
A: Nonlinear because, for the input $x[n] = u[n]$, doubling the input does not double the output.
B: Linear because an input of zero for all n gives an output of zero for all n.
C: Nonlinear because an input of zero for all n does not give an output of zero for all n.
D: Linear because, for all inputs $x_1[n]$ and $x_2[n]$ and all constants a_1 and a_2, the output due to $a_1 x_1[n] + a_2 x_2[n]$ is $a_1 y_1[n] + a_2 y_2[n]$, where $y_1[n]$ is the output due to $x_1[n]$ and $y_2[n]$ is the output due to $x_2[n]$.
E: Nonlinear because, for the input $x[n] = 1$ for all n, the output is not linear.

Question 3: Consider the system with input $x[\cdot]$ and output $y[\cdot]$ such that $y[n] = \frac{n}{n+1} x[n]$. This system is
A: Unstable because the input $x[n] = 1$ for all n gives an unbounded output.
B: Stable because $|x[n]| \leq A$ for all n implies that $|y[n]| \leq B$ for all n for $B = A$.
C: Unstable because the input $x[n] = u[n]$ gives an unbounded output.
D: Unstable because the input $x[n] = n + 1$ for all n gives an unbounded output.
E: Stable because the input $x[n] = 1$ for all n gives a bounded output.

Question 4: Consider an LTI system with impulse response $h[n] = 8\delta[n-2]$. This system is
A: Not causal, not stable, and not memoryless.
B: Stable but not causal and not memoryless.
C: Causal and stable but not memoryless.
D: Causal but not stable and not memoryless.
E: Causal, stable, and memoryless.

Question 5: Consider the system with input $x(\cdot)$ and output $y(\cdot)$ such that $y(t) = (t-2)x(-4)x^2(t)$. Is this system memoryless? Causal?
A: Memoryless but not causal.
B: There is insufficient information to determine an answer.
C: Memoryless and causal.
D: Causal but not memoryless.
E: Neither memoryless nor causal.

Question 6: Consider a LTI system with impulse response $h[n]$ and periodic input $\tilde{x}[n]$ with $N_0 = 4$ such that the convolution of the impulse response with the fundamental cycle of the input is $(x * h)[n] = 4 - |n|$ if $-3 \leq n \leq 3$ and 0 otherwise. If the output is $\tilde{y}[n]$, determine $\tilde{y}[1]$. Choose the closest answer.
A: 3.
B: 6.
C: 5.
D: 7.
E: 4.

Question 7: Consider a composite system in which System 1 is in series with the parallel combination of Systems 2 and 3. The systems have respective impulse responses $h_1[n] = 2\delta[n] - \delta[n-1]$, $h_2[n] = \delta[n] + 2\delta[n-1]$, and $h_3[n] = \delta[n] - \delta[n-1] + \delta[n-2]$. Determine the impulse response of the composite system. The answer has the form $h[n] = A\delta[n] + B\delta[n-1] + C\delta[n-2] + D\delta[n-3]$. Some of these coefficients might be zero. Determine $A + B + C + D$. Choose the closest answer.
A: 3.
B: 1.
C: 4.
D: 5.
E: 2.

Question 8: Consider the system defined by $y(t) = \begin{cases} x(t) & \text{if } -2 < x(t) < 2 \\ 2 & \text{if } x(t) \geq 2 \\ -2 & \text{if } x(t) \leq -2 \end{cases}$ where $x(\cdot)$ is the input and $y(\cdot)$ is the output. This system is

A: Invertible because the inverse system is $x(t) = \begin{cases} y(t) & \text{if } -2 < x(t) < 2 \\ 2 & \text{if } y(t) \geq 2 \\ -2 & \text{if } y(t) \leq -2 \end{cases}$.

B: Invertible because the inputs $x(t) = 3$ for all t and $x(t) = -3$ for all t give different outputs.

C: Not invertible because the inputs $x(t) = \sin(t)$ and $x(t) = 2\sin(t)$ give the same output.

D: Not invertible because the inputs $x(t) = 3$ for all t and $x(t) = 4$ for all t give the same output.

E: Invertible because the inverse system is $x(t) = \begin{cases} y(t) & \text{if } -\frac{1}{2} < x(t) < \frac{1}{2} \\ \frac{1}{2} & \text{if } y(t) \geq \frac{1}{2} \\ -\frac{1}{2} & \text{if } y(t) \leq -\frac{1}{2} \end{cases}$

Question 9: Suppose $x(t)$ and $h(t)$ have no impulses and

$$[x * h](t) = \begin{cases} (c + dt) & \text{if } -1 < t \leq 1 \\ (3 - t) & \text{if } 1 < t \leq 3 \\ 0 & \text{otherwise} \end{cases}$$

Assume $x(t)$ is "on" from $t = -2$ to $t = 0$ and $h(t)$ is "on" from $t = a$ to $t = b$. Use the "checking" properties of convolution to determine a, b, c, and d. What is $a + b + c + d$? Choose the closest answer.

A: 8.

B: 10.

C: 9.

D: 6.

E: 7.

Question 10: As part of a convolution problem, you are required to compute $\int_{-\infty}^{\infty} u(\tau - 1)u(t - \tau - 1)d\tau$ in the region $t > 2$. Determine the answer to this integral in this case. The answer has the form $At + B$. What is $A + B$? Choose the closest answer.

A: -4.

B: -1.

C: -3.

D: -5.

E: -2.

Question 11: Consider the system $y[n] = (n+2)x[n-2] - (n-1)x[n-1]$. Let $h[n]$ be the impulse response of this system. Determine $h[0] + h[1] + h[2]$. Choose the closest answer.
A: 3.
B: 0.
C: 1.
D: 4.
E: 2.

Question 12: In this problem use without proof the facts that $e^{-2t^2} * e^{-2t^2} = \frac{1}{2}\sqrt{\pi}e^{-t^2}$ and $te^{-2t^2} * e^{-2t^2} = \frac{1}{4}\sqrt{\pi}te^{-t^2}$. Determine the convolution of $te^{-2(t-1)^2}$ with e^{-2t^2}. The answer can be written in the form $\frac{1}{4}\sqrt{\pi}(At+B)e^{-(t-C)^2}$. Determine $A+B+C$. Choose the closest answer. *Hint:* Use properties. You may find it helpful to write $t = (t-1)+1$.
A: 3.
B: 2.
C: 4.
D: 5.
E: 1.

Test 201 Answers: ADDB BDEA BCAA

(There was a minor error in problem 11, which has been corrected in this version. There was a more serious error in problem 3. Credit was given or not given based on work shown on the exam. The problem has been changed in this version to match what was intended.)

Serial Number: **201** Name:

ECE 3300 Fall 2016 (Signals, Systems, and Transforms): Exam II

Record your name on this test; record your name, student ID, and test serial number on the scantron. Enter the test serial number in *COURSE*; you may leave *SECTION* blank. You must show your work on every problem, showing all steps on your test. Do not use scratch paper or write your work anywhere but on the test. The examination lasts 60 minutes and you may use two sheets of notes (front and back); no old test questions can be on your notes. Calculator use is permitted. There is one correct answer per question. In problems asking to find coefficients A, B, C, etc., some of these coefficients may equal zero.

Question 1: Suppose $x(t)$ and $h(t)$ have no impulses and $x(t)$ is "on" from $t = 1$ to $t = 2$ and $h(t)$ is "on" from $t = 0$ to $t = 3$. Further suppose that

$$[x * h](t) = \begin{cases} A + (t-3)^2 & \text{if } B < t \leq C \\ 0 & \text{otherwise} \end{cases}$$

Use the "checking" properties of convolution to determine A, B, and C. What is $A + B + C$? Choose the closest answer.
A: 2.
B: 6.
C: 8.
D: 4.
E: 10.

Question 2: Consider the system defined by $y[n] = x[n] - x[-n]$ where $x[\cdot]$ is the input and $y[\cdot]$ is the output. This system is
A: Invertible because the inputs $x[n] = \delta[n]$ and $x[n] = \delta[n-1]$ give different outputs.
B: Not invertible because the inputs $x[n] = u[n]$ and $x[n] = u[-n]$ give the same output.
C: Invertible because the inverse system is $x[n] = y[n] + y[-n]$.
D: Not invertible because the inputs $x[n] = 1$ for all n and $x[n] = 2$ for all n give the same output.
E: Not invertible because the inputs $x[n] = \delta[n]$ and $x[n] = \delta[n-1]$ give the same output.

Question 3: Consider a composite system in which System 1 is in series with the parallel combination of Systems 2 and 3. The systems have respective impulse responses $h_1[n] = \delta[n]+\delta[n-2]$, $h_2[n] = \delta[n]+2\delta[n-1]$, and $h_3[n] = \delta[n]-\delta[n-2]$. Determine the impulse response of the composite system. The overall impulse response is denote $h[n]$. Determine $h[2]+h[3]+h[4]$. Choose the closest answer.
A: 0.
B: 3.
C: 4.
D: 2.
E: 1.

Question 4: Suppose $a(t)$, $b(t)$, and $c(t)$ are signals such that $[a*a](t) = b(t)$ and $[a*b](t) = c(t)$. Determine the convolution of $a(t-1) - b(t)$ with $2a(t-2)$. The answer has the form $Ab(t-B) + Cc(t-D)$. What is $A+B+C+D$? Choose the closest answer.
A: 7.
B: 5.
C: 6.
D: 8.
E: 9.

Question 5: Consider a LTI system with impulse response $h[n]$ and periodic input $\tilde{x}[n]$ with $N_0 = 3$ such that the convolution of the impulse response with the fundamental cycle of the input is $(x*h)[n] = 3\delta[n] - 4\delta[n-1] + 3\delta[n-2] + 2\delta[n-3] + \delta[n-4] - \delta[n-5] - \delta[n-6]$. If the output is $\tilde{y}[n]$, determine $\tilde{y}[0]$ and $\tilde{y}[1]$. What is the sum of these two values? Choose the closest answer.
A: 2.
B: 1.
C: 0.
D: -1.
E: -2.

Question 6: Consider the system with input $x(\cdot)$ and output $y(\cdot)$ such that $y(t) = (\frac{t+1}{t+2})x(t)$. This system is
A: Stable because the input $x(t) = 0$ for all t gives a bounded output.
B: Unstable because the input $x(t) = u(t+1)$ gives an unbounded output.
C: Stable because $|x(t)| \leq A$ for all t implies that $|y(t)| \leq B$ for all t for $B = A$.
D: Unstable because the input $x(t) = 1$ for all t gives an unbounded output.
E: Unstable because the input $x(t) = t+2$ for all t gives an unbounded output.

Question 7: Consider an LTI system with impulse response $h[n] = 4\delta[n] + 5u[n-10]$. This system is
A: Not causal, not stable, and not memoryless.
B: Causal and stable but not memoryless.
C: Causal, stable, and memoryless.
D: Stable but not causal and not memoryless.
E: Causal but not stable and not memoryless.

Question 8: Consider the system $y[n] = 2^n(x[n] - x[n-2])x[n-1]$. Let $g[n]$ be the step response of this system. Determine $g[0] + g[1] + g[2]$. Choose the closest answer.
A: 2.
B: 1.
C: 5.
D: 3.
E: 4.

Question 9: Consider the system $y[n] = x[n-2]\cos(x[n+3])$. This system is
A: Time-varying because the output due to $x[n] = \frac{\pi}{2}u[n-1]$ is not a delay by 1 of the output due to $x[n] = \frac{\pi}{2}u[n]$.
B: Time-invariant because, for all inputs $x[\cdot]$ and all values n_0, the output due to $x[\cdot - n_0]$ is a delay by n_0 of the output due to $x[\cdot]$.
C: Time-invariant because $x[n-2]$ is a delay by 5 of $x[n+3]$.
D: Time-varying because the output due to $x[n] = u[n-1]$ is not a delay by 1 of the output due to $x[n] = u[n]$.
E: Time-varying because the output due to $x[n] = nu[n-1]$ is a delay by 1 of the output due to $x[n] = nu[n]$.

Question 10: Consider the system with input $x(\cdot)$ and output $y(\cdot)$ such that $y(t) = x(t)e^{-t^2} - x(0)$. This system is
A: Linear because $y(t) \leq x(t)$ for all t.
B: Nonlinear because an input of $x(t) = e^{t^2}$ for all t gives an output of zero for all t.
C: Linear because, for all inputs $x_1(t)$ and $x_2(t)$ and all constants a_1 and a_2, the output due to $a_1x_1(t) + a_2x_2(t)$ is $a_1y_1(t) + a_2y_2(t)$, where $y_1(t)$ is the output due to $x_1(t)$ and $y_2(t)$ is the output due to $x_2(t)$.
D: Linear because an input of zero for all t gives an output of zero for all t.
E: Nonlinear because, for the input $x(t) = e^{t^2}$ for all t, doubling the input does not double the output.

Question 11: As part of a convolution problem, you are required to compute $\int_0^\infty (2te^{-\tau} + 2e^{-2\tau})d\tau$. Determine the answer to this integral in this case. The answer has the form $A + Bt + Ce^{-t} + De^{-2t}$. What is $A + B + C + D$? Choose the closest answer.
A: 3.
B: 4.
C: 2.
D: 1.
E: 5.

Question 12: Consider the system with input $x(\cdot)$ and output $y(\cdot)$ such that $y(t) = x(0) + e^{t+2}x(t)$. Is this system memoryless? Causal?
A: Neither memoryless nor causal.
B: There is insufficient information to determine an answer.
C: Memoryless but not causal.
D: Memoryless and causal.
E: Causal but not memoryless.

Test 201 Answers: ACAE DDBD DCDA

On Problem 8, E is also correct. On Problem 12, B is also correct.

Serial Number: **201** Name:

ECE 3300 Spring 2016 (Signals, Systems, and Transforms): Exam II

Record your name on this test; record your name, student ID, and test serial number on the scantron. Enter the test serial number in *COURSE*; you may leave *SECTION* blank. You must show your work on every problem, showing all steps on your test. Do not use scratch paper or write your work anywhere but on the test. The examination lasts 50 minutes and you may use two sheets of notes (front and back); no old test questions can be on your notes. Calculator use is permitted. There is one correct answer per question. In problems asking to find coefficients A, B, C, etc., some of these coefficients may equal zero.

Question 1: Consider a LTI system with impulse response $h(t)$ and periodic input $\tilde{x}(t)$ with $T_0 = 3$ such that the convolution of the impulse response with the fundamental cycle of the input is $[x * h](t) = t(u(t) - u(t-2)) + 2(u(t-2) - u(t-6)) + (8-t)(u(t-6) - u(t-8))$. If the output is $\tilde{y}(t)$, determine $\tilde{y}(1)$. Choose the closest answer.
A: 4.
B: 5.
C: 3.
D: 6.
E: 7.

Question 2: Consider the system with input $x[\cdot]$ and output $y[\cdot]$ such that $y[n] = x[2n+1] - x[2n]$. This system is
A: Nonlinear because $x[2n+1]$ is not equal to $x[0]$ at $n = 0$.
B: Nonlinear because an input of $x[n] = 1$ for all n gives an output of zero for all n.
C: Linear because, for all inputs $x_1[n]$ and $x_2[n]$ and all constants a_1 and a_2, the output due to $a_1x_1[n] + a_2x_2[n]$ is $a_1y_1[n] + a_2y_2[n]$, where $y_1[n]$ is the output due to $x_1[n]$ and $y_2[n]$ is the output due to $x_2[n]$.
D: Nonlinear because, for the input $x[n] = u[n]$, doubling the input does not double the output.
E: Linear because an input of zero for all n gives an output of zero for all n.

Question 3: Consider an LTI system with impulse response $h(t) = \frac{1}{t^2}u(-t-1)$. This system is
A: Stable but not causal and not memoryless.
B: Causal but not stable and not memoryless.
C: Causal and stable but not memoryless.
D: Not causal, not stable, and not memoryless.
E: Causal, stable, and memoryless.

Question 4: Consider a composite system in which System 1 is in parallel with the series combination of Systems 2 and 3. The systems have respective impulse responses $h_1(t) = (1+t)e^{-t}u(t)$, $h_2(t) = \delta(t) - e^{-t}u(t)$, and $h_3(t) = e^{-t}u(t)$. Determine the impulse response of the composite system. The answer has the form $h(t) = A\delta(t) + (B + Ct + Dt^2)e^{-t}u(t)$. Determine $A+B+C+D$. Choose the closest answer. *Hint:* The following facts may be used without proof: $e^{-t}u(t) * e^{-t}u(t) = te^{-t}u(t)$, $e^{-t}u(t) * te^{-t}u(t) = \frac{t^2}{2}e^{-t}u(t)$.
A: 4.
B: 1.
C: 3.
D: 5.
E: 2.

Question 5: As part of a convolution problem, you are required to compute $\int_0^t 2(t+\tau)d\tau$. Determine the answer to this integral in this case. The answer has the form $At^2 + Bt + C$. What is $A + B + C$? Choose the closest answer.
A: 1.
B: 2.
C: 5.
D: 3.
E: 4.

Question 6: Consider the system $y(t) = tx(t - \frac{1}{2}) + (t-1)x(t - \frac{3}{2})$. Let $g(t)$ be the step response of this system. Determine $g(0) + g(1) + g(2)$. Choose the closest answer.
A: 1.
B: 2.
C: 3.
D: 4.
E: 5.

Question 7: Suppose $x(t)$ and $h(t)$ have no impulses and

$$[x * h](t) = \begin{cases} (A + Bt) & \text{if } 2 < t \leq 3 \\ C & \text{if } 3 < t \leq 4 \\ 2e^{-(t-4)} & \text{if } t > 4 \\ 0 & \text{otherwise} \end{cases}$$

Use the "checking" properties of convolution to determine A, B, and C. What is $A + B + C$? Choose the closest answer.
A: 4.
B: 0.
C: 1.
D: 2.
E: 3.

Question 8: Consider the system $y[n] = x[n] - n$. This system is
A: Time-invariant because the output due to $x[n] = n - 1$ is a delay by 1 of the output due to $x[n] = n$.
B: Time-invariant because the output due to $x[n] = (-1)^{n-2}$ is a delay by 2 of the output due to $x[n] = (-1)^n$.
C: Time-invariant because, for all inputs $x[\cdot]$ and all values n_0, the output due to $x[\cdot - n_0]$ is a delay by n_0 of the output due to $x[\cdot]$.
D: Time-varying because the output due to $x[n] = n - 1$ is not a delay by 1 of the output due to $x[n] = n$.
E: Time-varying because the output due to $x[n] = (-1)^{n-2}$ is not a delay by 2 of the output due to $x[n] = (-1)^n$.

Question 9: Determine the convolution of $2\delta[n] - \delta[n-1] - 2\delta[n-2] + 2\delta[n-3]$ with $\delta[n-1] - \delta[n-2] + \delta[n-3]$. The answer can be written in the form $A\delta[n-1] + B\delta[n-2] + C\delta[n-3] + D\delta[n-4] + E\delta[n-5] + F\delta[n-6]$. Determine $B + D + F$. Choose the closest answer.
A: 0.
B: 1.
C: 3.
D: 2.
E: 4.

Question 10: Consider the system with input $x[\cdot]$ and output $y[\cdot]$ such that $y[n] = (n+1)x[n-1] + (n-2)x[n]$. Is this system memoryless? Causal?
A: Memoryless and causal.
B: There is insufficient information to determine an answer.
C: Causal but not memoryless.
D: Neither memoryless nor causal.
E: Memoryless but not causal.

Question 11: Consider the system with input $x[\cdot]$ and output $y[\cdot]$ such that $y[n] = x[n]x[n-1]x[n-2]x[n-3]$. This system is

A: Unstable because the input $x[n] = \frac{1}{n}$ for all n gives an unbounded output.
B: Stable because the input $x[n] = 1$ for all n gives a bounded output.
C: Stable because the input $x[n] = 0$ for all n gives output $y[n] = 0$ for all n.
D: Stable because $|x[n]| \leq A$ for all n implies that $|y[n]| \leq B$ for all n for $B = A^4$.
E: Unstable because the input $x[n] = n$ for all n gives an unbounded output.

Question 12: Consider the system defined by $y(t) = x(t+1)u(t+1)$ where $x(\cdot)$ is the input and $y(\cdot)$ is the output. This system is

A: Not invertible because the inputs $x(t) = 1$ for all t and $x(t) = u(t+2)$ give the same output.
B: Not invertible because the inputs $x(t) = 1$ for all t and $x(t) = u(t)$ give the same output.
C: Invertible because the inverse system is $x(t) = \frac{y(t-1)}{u(t)}$.
D: Invertible because the inputs $x(t) = 1$ for all t and $x(t) = -1$ for all t give different outputs.
E: Invertible because the inverse system is $x(t) = \frac{y(t-1)}{u(t-1)}$.

Test 201 Answers: CCAB ECDE ADCB

Serial Number: **201** Name:

ECE 3300 Spring 2017 (Signals, Systems, and Transforms): Exam II

Record your name on this test; record your name, student ID, and test serial number on the scantron. Enter the test serial number in *COURSE*; you may leave *SECTION* blank. You must show your work on every problem, showing all steps on your test. Do not use scratch paper or write your work anywhere but on the test. The examination lasts 60 minutes and you may use two sheets of notes (front and back); no old test questions can be on your notes. Calculator use is permitted. There is one correct answer per question. In problems asking to find coefficients A, B, C, etc., some of these coefficients may equal zero.

Question 1: Consider the system with input $x[\cdot]$ and output $y[\cdot]$ such that $y[n] = n(x[n-3] - x[n-2])$. Is this system memoryless? Causal?
A: Neither memoryless nor causal.
B: Memoryless but not causal.
C: Causal but not memoryless.
D: Memoryless and causal.
E: There is insufficient information to determine an answer.

Question 2: Consider the system $y(t) = x(t) + 2x(0)$. This system is
A: Time-varying because the output due to $x(t) = t - 1$ is a delay by 2 of the output due to $x(t) = t$.
B: Time-invariant because the output due to $x(t) = t - 1$ is a delay by 1 of the output due to $x(t) = t$.
C: Time-varying because the output due to $x(t) = t - 1$ is a delay by 3 of the output due to $x(t) = t$.
D: Time-invariant because when the input does not vary over time, neither does the output.
E: Time-invariant because, for all inputs $x(\cdot)$ and all values t_0, the output due to $x(\cdot - t_0)$ is a delay by t_0 of the output due to $x(\cdot)$.

Question 3: Consider a LTI system with impulse response $h[n]$ and periodic input $\tilde{x}[n]$ with $N_0 = 4$ such that the convolution of the impulse response with the fundamental cycle of the input is $(x * h)[n] = (2 - (-1)^n)(u[n] - u[n-6])$. If the output is $\tilde{y}[n]$, determine $\tilde{y}[0]$, $\tilde{y}[1]$, and $\tilde{y}[2]$. What is the sum of these three values? Choose the closest answer.
A: 9.
B: 7.
C: 6.
D: 10.
E: 8.

Question 4: Let $y[n]$ denote the convolution of $x[n] = (n+1)(u[n] - u[n-3])$ and $h[n] = (-1)^n(u[n] - u[n-3])$. Determine the sum of $y[1]$, $y[2]$, and $y[3]$. Choose the closest answer.
A: 1.
B: 2.
C: 3.
D: 4.
E: 5.

Question 5: Consider a composite system in which the parallel combination of Systems 1 and 2 is in series with the parallel combination of Systems 3 and 4. All systems are LTI and have respective impulse responses $h_1(t) = e^{-t}u(t) + \delta(t)$, $h_2(t) = 2e^{-t}u(t) - \delta(t)$, $h_3(t) = 3e^{-t}u(t) + \delta(t)$, and $h_4(t) = -4e^{-t}u(t) + \delta(t)$. Determine the impulse response of the composite system. The answer has the form $A\delta(t) + (B + Ct)e^{-t}u(t)$. What is $A + B + C$? Choose the closest answer. *Hint:* You may use without proof the fact that $e^{-t}u(t)$ convolved with itself equals $te^{-t}u(t)$.
A: 2.
B: 4.
C: 5.
D: 1.
E: 3.

Question 6: Suppose $x(t)$ and $h(t)$ have no impulses and further suppose that

$$[x * h](t) = \begin{cases} \frac{A}{t} + B & \text{if } 2 < t \leq 3 \\ C & \text{if } 3 < t \leq 4 \\ \frac{4}{t} & \text{if } t > 4 \\ 0 & \text{otherwise} \end{cases}$$

Use the "checking" properties of convolution to determine A, B, and C. What is $A + B + C$? Choose the closest answer.
A: -1.
B: 1.
C: -2.
D: 0.
E: 2.

Question 7: Consider the system with input $x[\cdot]$ and output $y[\cdot]$ such that $y[n] = x[n-1] - n$. This system is
A: Linear because $y[0] = x[-1]$, and thus, an input of zero at time -1 gives an output of zero at time 0.
B: Nonlinear because an input of $x[n] = n$ for all n gives an output of zero for all n.
C: Nonlinear because $y[1] = x[0] - 1$ but $y[2] = x[1] - 2$; that is, doubling n from $n = 1$ to $n = 2$ does not double $y[n]$ unless $x[1] = 2x[0]$.
D: Nonlinear because, for the input $x[n] = 1$ for all n, doubling the input does not double the output.
E: Linear because, for all inputs $x_1[n]$ and $x_2[n]$ and all constants a_1 and a_2, the output due to $a_1x_1[n] + a_2x_2[n]$ is $a_1y_1[n] + a_2y_2[n]$, where $y_1[n]$ is the output due to $x_1[n]$ and $y_2[n]$ is the output due to $x_2[n]$.

Question 8: Consider an LTI system with impulse response $h(t) = 12e^t u(-t) - 12\delta(t)$. This system is
A: Causal and stable but not memoryless.
B: Causal, stable, and memoryless.
C: Causal but not stable and not memoryless.
D: Not causal, not stable, and not memoryless.
E: Stable but not causal and not memoryless.

Question 9: Consider the system with input $x[\cdot]$ and output $y[\cdot]$ such that $y[n] = n(u[n] - u[n-11])x[n]$. This system is
A: Stable because $|x[n]| \leq A$ for all n implies that $|y[n]| \leq B$ for all n for $B = 10A$.
B: Unstable because the input $x[n] = n$ for all n gives an unbounded output.
C: Unstable because the input $x[n] = \frac{1}{n-1}$ for all n gives an unbounded output.
D: Unstable because the input $x[n] = 1$ for all n gives an unbounded output.
E: Stable because the input $x[n] = 0$ for all n gives a bounded output.

Question 10: Consider the system $y[n] = \frac{4x[n]+2x[n-1]+2x[n-2]}{x[n]+x[n-1]+1}$. Let $h[n]$ be the impulse response of this system. Determine $h[0] + h[1] + h[2]$. Choose the closest answer.
A: 1.
B: 2.
C: 3.
D: 5.
E: 4.

Question 11: Suppose $x(t) = e^{-t}u(t-1)$ and $h(t) = u(t+2) - u(t+1)$. The convolution of $x(t)$ and $h(t)$ is a piecewise function that has the form

$$[x * h](t) = \begin{cases} f_1(t) & \text{if } t < A \\ f_2(t) & \text{if } A \leq t < B \\ f_3(t) & \text{if } t \geq B \end{cases}$$

What is B? Choose the closest answer. *Hint:* Determine the convolution regions but do not determine $f_1(t)$, $f_2(t)$, or $f_3(t)$.
A: -2.
B: 1.
C: 0.
D: -1.
E: 2.

Question 12: Consider the system defined by $y(t) = e^{-t}\sin(x(t))$ where $x(\cdot)$ is the input and $y(\cdot)$ is the output. This system is
A: Not invertible because the inputs $x(t) = \frac{\pi}{2}$ for all t and $x(t) = -\frac{\pi}{2}$ for all t give the same output.
B: Not invertible because the inputs $x(t) = 0$ for all t and $x(t) = \pi u(t)$ give the same output.
C: Invertible because the inverse system is $x(t) = e^{t}\sin^{-1}(y(t))$.
D: Invertible because the inputs $x(t) = t$ for all t and $x(t) = -t$ for all t give different outputs.
E: Not invertible because the inputs $x(t) = t$ for all t and $x(t) = -t$ for all t give the same output.

Answers to Test 301: CDEC DABD CECE

Serial Number: **301** Name:

ECE 3300 Fall 2015 (Signals, Systems, and Transforms): Exam III

Record your name on this test; record your name, student ID, and test serial number on the scantron. Enter the test serial number in *COURSE*; you may leave *SECTION* blank. You must show your work on every problem, showing all steps on your test. Do not use scratch paper or write your work anywhere but on the test. The examination lasts 50 minutes and you may use three sheets of notes (front and back); no old test questions can be on your notes. Calculator use is permitted. There is one correct answer per question.

Question 1: In this problem use without proof the fact that $\sum_{n=0, n \text{ even}}^{\infty} a^n = \frac{1}{1-a^2}$ if $|a| < 1$. Using the definition of the Fourier transform, determine $X(e^{j\omega})$ if $x[n] = (\frac{1}{2})^n$ if $n \geq 0$ and n is even, and $x[n] = 0$ otherwise. The answer can be written in the form $\frac{A}{B-e^{-Cj\omega}}$. Determine $A + B + C$. Choose the closest answer.
A: 9.
B: 6.
C: 10.
D: 8.
E: 7.

Question 2: Given that $x(t)$ has Fourier transform $\frac{1}{(1+\omega^2)^2}$, determine the Fourier transform of $tx(t)$. The answer has the form $\frac{A+Bj\omega}{(1+\omega^2)^C}$. What is $A + B + C$? (Some of these coefficients may equal zero.) Choose the closest answer.
A: 0.
B: -2.
C: 2.
D: -1.
E: 1.

Question 3: Determine the inverse Fourier transform $x[n]$ if $X(e^{j\omega}) = (1 - 2e^{-j\omega})^2$. What is $x[1] + x[2]$? Choose the closest answer. *Hint:* Expand the square.
A: -2.
B: -1.
C: 1.
D: 2.
E: 0.

Question 4: Suppose $\tilde{x}(t)$ has Fourier series coefficients $x_k = \frac{1}{\sqrt{(|k|+1)(|k|+2)}}$ for all k. Determine the mean-square error between $\tilde{x}(t)$ and $\tilde{x}_2(t) = \sum_{k=-2}^{2} x_k e^{jk2\pi t/T_0}$ as a percentage of the total power $P_{\tilde{x}}$. Choose the closest answer. *Hint:* You may use without proof the fact that $P_{\tilde{x}} = \frac{3}{2}$.
A: 40%.
B: 10%.
C: 30%.
D: 50%.
E: 20%.

Question 5: Given that $\sqrt{2}e^{-\sqrt{2}|t|}$ has Fourier transform $\frac{4}{2+\omega^2}$, determine the Fourier transform of $\int_{-\infty}^{t} \sqrt{2}e^{-\sqrt{2}|\tau|}d\tau$. The answer has the form $\frac{4}{j(A+B\omega+C\omega^2+D\omega^3)} + E\pi\delta(\omega)$. (Some of these coefficients may equal zero.) Determine $A+B+C+D+E$. Choose the closest answer.
A: 7.
B: 9.
C: 6.
D: 5.
E: 8.

Question 6: Given that, for $-1 < a < 1$, $a^n u[n]$ has Fourier transform $\frac{1}{1-ae^{-j\omega}}$, determine the Fourier transform of $x[n] = (\frac{1}{2})^{n-2}u[n-1]$. What is $X(e^{j0})$? Choose the closest answer. *Hint:* $(\frac{1}{2})^{n-2} = (\frac{1}{2})^{n-1}(\frac{1}{2})^{-1}$.
A: 4.
B: 5.
C: 3.
D: 1.
E: 2.

Question 7: Suppose $\tilde{x}(t)$ has fundamental cycle $x(t) = 2\pi\cos(t)\text{rect}(\frac{t}{\pi})$ and fundamental period $T_0 = 2\pi$. Determine the Fourier series coefficients x_k. What is $x_0 + x_2$? Choose the closest answer. *Hint:* You may use without proof the fact that the Fourier transform of the fundamental cycle is $X(j\omega) = \frac{4\pi\cos(\pi\omega/2)}{1-\omega^2}$.

A: 1.
B: 3.
C: 5.
D: 2.
E: 4.

Question 8: Suppose $x[n] = \delta[n] - \frac{1}{2}(\frac{1}{2})^n u[n]$. Determine the magnitude of the Fourier transform. The answer has the form $|X(e^{j\omega})| = \frac{\sqrt{A-B\cos(\omega)}}{\sqrt{C-\cos(\omega)}}$. Determine $A + B + C$. Choose the closest answer.

A: 3.
B: 1.
C: 4.
D: 2.
E: 5.

Question 9: Suppose $x(t) = f(t)u(t)$ has Fourier transform $X(j\omega) = \frac{1+j\omega}{2+j\omega}$. Determine the Fourier transform of $y(t) = f(|t|)$. The answer has the form $\frac{A+B\omega^2}{C+\omega^2}$. Determine $A + B + C$. Choose the closest answer. *Hint:* Note that $y(t) = x(t) + x(-t)$.

A: 8.
B: 7.
C: 10.
D: 9.
E: 6.

Question 10: Suppose $|X(j\omega)| = \begin{cases} 3 & \text{if } 0 < |\omega| \leq 1 \\ 2 & \text{if } 2 < |\omega| < 6 \\ 0 & \text{otherwise} \end{cases}$.

Determine the percentage of energy in the frequency band $(1, 5)$. Choose the closest answer.

A: 10%.
B: 30%.
C: 20%.
D: 40%.
E: 50%.

Question 11: Suppose $x(t)$ is a real, even signal, and suppose $X(j\omega) = \frac{(1-\omega^2)(4-\omega^2)}{9-\omega^2}$. At what ranges of frequencies does $\angle X(j\omega)$ equal zero?
A: $1 < |\omega| < 2$ and $|\omega| > 3$ only.
B: $1 < |\omega| < 2$ only.
C: $|\omega| < 1$ and $2 < |\omega| < 3$ only.
D: $2 < |\omega| < 3$ only.
E: $|\omega| < 1$ and $|\omega| > 3$ only.

Question 12: Suppose $\tilde{x}(t)$ has Fourier transform $\tilde{X}(j\omega) = \sum_{k=-6}^{6} \frac{4\pi}{k^2-2}\delta(\omega - k\pi)$. Determine the Fourier series coefficient x_2 and the fundamental period T_0. What is $x_2 + T_0$? Choose the closest answer.
A: 4.
B: 5.
C: 6.
D: 7.
E: 3.

Answers to Test 301: BCBE DEDB DEDB

Serial Number: **301** Name:

ECE 3300 Fall 2016 (Signals, Systems, and Transforms): Exam III

Record your name on this test; record your name, student ID, and test serial number on the scantron. Enter the test serial number in *COURSE*; you may leave *SECTION* blank. You must show your work on every problem, showing all steps on your test. Do not use scratch paper or write your work anywhere but on the test. Circle your answers on the test and bubble in the corresponding answers on your scantron. The examination lasts 60 minutes and you may use three sheets of notes (front and back); no old test questions can be on your notes. Calculator use is permitted. There is one correct answer per question. In problems asking to find coefficients A, B, C, etc., some of these coefficients may equal zero.

Question 1: Determine $x[n]$ if $X(e^{j\omega}) = \frac{4e^{-2j\omega}}{2+e^{-j\omega}}$. The answer has the form $A(\frac{1}{B})^{n-C}u[n-C]$. What is $A+B+C$? Choose the closest answer. *Hint:* Work from the fact that, if $-1 < a < 1$, $a^n u[n] \leftrightarrow \frac{1}{1-ae^{-j\omega}}$.
A: 10.
B: 2.
C: 8.
D: 4.
E: 6.

Question 2: Suppose $\tilde{x}(t)$ has fundamental cycle $x(t)$ and fundamental period $T_0 = 4\pi$. If the Fourier transform of the fundamental cycle is $X(j\omega) = \frac{4\pi}{\omega^2}\sin^2(\frac{\pi\omega}{2})$, determine the Fourier series coefficient x_1. Choose the closest answer.
A: 6.
B: 8.
C: 2.
D: 10.
E: 4.

Question 3: Suppose $|X(j\omega)| = \sqrt{9-\omega^2}\text{rect}(\frac{\omega}{6})$. Determine the percentage of energy in the frequency band $(0,1)$. Choose the closest answer. *Hint:* Recall that $\text{rect}(\frac{\omega}{2a}) = 1$ for $-a < \omega < a$ and 0 otherwise.
A: 30%.
B: 50%.
C: 40%.
D: 60%.
E: 70%.

Question 4: Suppose $x[n] = (\frac{1}{2})^n u[n] - (\frac{1}{3})^n u[n]$. Determine the magnitude of the Fourier transform. The answer has the form $|X(e^{j\omega})| = \frac{A}{\sqrt{B-\cos\omega}\sqrt{C-\frac{2}{3}\cos(\omega)}}$. What is $A+B+C$? Choose the closest answer.
A: 5.
B: 4.
C: 2.
D: 1.
E: 3.

Question 5: Suppose $x[n]$ is a real, even signal, and suppose $X(e^{j\omega}) = (\frac{1}{2} - \cos\omega)(\frac{\sqrt{3}}{2} + \cos\omega)$. For $0 < \omega < \pi$, in which of the following regions is $\angle X(e^{j\omega})$ equal to zero?
A: $\frac{\pi}{6} < \omega < \frac{2\pi}{3}$.
B: $\angle X(e^{j\omega})$ is never equal to zero over $0 < \omega < \pi$.
C: $0 < \omega < \frac{\pi}{3}$ and $\frac{5\pi}{6} < \omega < \pi$.
D: $\frac{\pi}{3} < \omega < \frac{5\pi}{6}$.
E: $0 < \omega < \frac{\pi}{6}$ and $\frac{2\pi}{3} < \omega < \pi$.

Question 6: Determine the Fourier transform of $(e^{-t} + e^{-2t})^2 u(t)$. The answer has the form $\frac{A}{B+j\omega} + \frac{C}{D+j\omega} + \frac{E}{F+j\omega}$. What is $A+B+C+D+E+F$? Choose the closest answer. *Hint:* Expand the square.
A: 14.
B: 15.
C: 12.
D: 11.
E: 13.

Question 7: Suppose $\tilde{x}(t)$ has period $T_0 = 4$ and Fourier series coefficients $x_k = \frac{k^2}{|k|+4}$. One of the terms in the Fourier transform of $\tilde{x}(t)$ is $A\delta(\omega - 2\pi)$. What is A? Choose the closest answer.
A: π.
B: 3π.
C: 5π.
D: 4π.
E: 2π.

Question 8: Given that, if $a > 0$, $\sqrt{t}e^{-at}u(t) \leftrightarrow \frac{\sqrt{\pi}}{2}\frac{1}{(a+j\omega)^{3/2}}$, determine the Fourier transform of $\int_{-\infty}^{t}\sqrt{\tau}e^{-2\tau}u(\tau)d\tau$. The answer has the form $\frac{\sqrt{\pi}}{2}\frac{1}{j\omega(2+j\omega)^{3/2}} + \frac{\pi^A}{B}\delta(\omega)$. What is $A + B$? Choose the closest answer.
A: 8.
B: 7.
C: 6.
D: 9.
E: 10.

Question 9: Suppose $p[n]$ is a sequence of numbers such that $\sum_{n=1}^{\infty} p[n]a^n = \ln(G(1-a))$, where $G(\cdot)$ is a function. Consider the signal $x[n] = (\frac{1}{2})^n p[n]u[n-1]$. Determine $X(e^{j\omega})$.
A: $\frac{\ln(G(1-e^{j\omega}))}{1-\frac{1}{2}e^{-j\omega}}$.
B: $\ln(G(1-\frac{1}{2}e^{j\omega}))$.
C: $\frac{\ln(G(1-e^{-j\omega}))}{1-\frac{1}{2}e^{-j\omega}}$.
D: $\ln(G(1-\frac{1}{2}e^{-j\omega}))$.
E: $(\frac{1}{2})^n \ln(G(1-e^{j\omega}))$.

Question 10: Suppose $x[n]$ has Fourier transform $X(e^{j\omega})$. Determine the Fourier transform of $y[n] = x[n+2]-x[n]+x[n-2]$. The answer has the form $(A\cos(B\omega) + C)X(e^{j\omega})$. What is $A + B + C$? Choose the closest answer.
A: 2.
B: 4.
C: 5.
D: 1.
E: 3.

Question 11: Given that $x(t)$ has Fourier transform $\frac{\frac{1}{4}}{(1+2j\omega)^4}$, determine the Fourier transform of $tx(t)$. The answer has the form $\frac{A+jB}{(1+2j\omega)^C}$, where A, B, and C are real. What is $A+B+C$? Choose the closest answer.
A: 9.
B: 6.
C: 8.
D: 7.
E: 10.

Question 12: Suppose $\tilde{x}(t)$ has period $T_0 = \pi$ and Fourier series coefficients $x_k = jk$ if $-4 \leq k \leq 4$ and $x_k = 0$ otherwise. Determine the percentage of power in the frequency band $[3, 7]$. Choose the closest answer.
A: 30%.
B: 40%.
C: 10%.
D: 50%.
E: 20%.

Answers to Test 301: CCEA BAAD EAAC

Serial Number: **301** Name:

ECE 3300 Spring 2016 (Signals, Systems, and Transforms): Exam III

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Question 1: Suppose $|X(j\omega)| = \begin{cases} \sqrt{1+3\omega^2} & \text{if } 0 < |\omega| \leq 1 \\ 2 & \text{if } 1 < |\omega| < 2 \\ 0 & \text{otherwise} \end{cases}$.
Determine the percentage of energy in the frequency band $(0, 1)$. Choose the closest answer.
A: 70%.
B: 60%.
C: 30%.
D: 40%.
E: 50%.

Question 2: Suppose $\tilde{x}(t)$ has Fourier transform $\tilde{X}(j\omega) = 4\pi\delta(\omega+\pi) - 2\pi\delta(\omega+\frac{\pi}{2}) + 4\pi\delta(\omega) - 2\pi\delta(\omega-\frac{\pi}{2}) + 4\pi\delta(\omega-\pi)$. Determine the Fourier series coefficients x_1 and x_2 and the fundamental period T_0. What is $x_1 + x_2 + T_0$? Choose the closest answer.
A: 4.
B: 3.
C: 5.
D: 7.
E: 6.

Question 3: Suppose $x[n]$ is a real, odd signal, and suppose $X(e^{j\omega}) = \frac{j\sin(\pi\omega)}{1-\omega^2}$. Determine $\angle X(j\omega)$ at $\omega = \frac{1}{2}$ (call this value A), $\omega = \frac{3}{2}$ (call this value B), and $\omega = \frac{5}{2}$ (call this value C). What is $A + 2B + 3C$? Choose the closest answer. *Hint:* A, B, and C should each be represented in the range $-\pi \leq \angle X(j\omega) < \pi$. Also, read carefully; the problem is not asking for $A + B + C$.
A: π.
B: $\pi/2$.
C: 2π.
D: $3\pi/2$.
E: 0.

Question 4: Determine the Fourier transform of $2\delta[n+2] - 2\delta[n-2]$. The answer can be written in the form $A\cos(B\omega) + Cj\sin(B\omega)$, where $B > 0$. What is $A + B + C$? Choose the closest answer.
A: 6.
B: 10.
C: 4.
D: 2.
E: 8.

Question 5: Suppose $x(t)$ has Fourier transform $\frac{2+3j\omega}{(1-2j\omega)^2}$. Determine the Fourier transform of $x(t) - 2\frac{d}{dt}x(t)$. The answer has the form $\frac{A+Bj\omega}{1+Cj\omega}$. Determine $A + B + C$. Choose the closest answer.
A: 1.
B: 3.
C: 4.
D: 2.
E: 5.

Question 6: Suppose $\tilde{x}[n]$ has fundamental cycle $x[n]$ and fundamental period $N_0 = 6$. If the Fourier transform of the fundamental cycle is $X(e^{j\omega}) = \frac{36}{1+2\cos^2(\omega)}$, determine the Fourier series coefficients x_k. What is $x_0 + x_1$? Choose the closest answer.
A: 6.
B: 7.
C: 9.
D: 10.
E: 8.

Question 7: In this problem use without proof the fact that $\sum_{n=0}^{\infty} \frac{a^n}{n!} = e^a$ for all a, even if complex-valued. Using the definition of the Fourier transform, determine $X(e^{j\omega})$ if $x[n] = \frac{(\frac{1}{2})^n}{n!}u[n]$. The answer can be written in the form $e^{(Ae^{Bj\omega})}$. Determine $A + B$. Choose the closest answer.
A: -0.5.
B: -2.5.
C: -1.5.
D: -1.0.
E: -2.0.

Question 8: Determine the Fourier transform of $((\frac{1}{2})^n + (-\frac{1}{2})^n)^2 u[n]$. The answer has the form $\frac{A}{1-Be^{-j\omega}} + \frac{C}{1-De^{-j\omega}}$. What is $A + B + C + D$? Choose the closest answer. *Hint:* Expand the square.
A: 5.
B: 1.
C: 2.
D: 4.
E: 3.

Question 9: Given that $\frac{\sqrt{2}}{2}e^{-\sqrt{2}|t|}$ has Fourier transform $\frac{2}{2+\omega^2}$, determine the Fourier transform of $\frac{\sqrt{2}}{2}te^{-\sqrt{2}|t|}$. The answer has the form $\frac{Aj\omega+B}{\omega^4+C\omega^2+D}$. Determine $A + B + C + D$. Choose the closest answer.
A: 12.
B: 8.
C: 6.
D: 10.
E: 4.

Question 10: Suppose $x(t) = 4e^{-t}u(t) - 3e^{-2t}u(t)$. Determine the magnitude of the Fourier transform. The answer has the form $|X(j\omega)| = \frac{\sqrt{A+\omega^2}}{\sqrt{B+\omega^2}\sqrt{C+\omega^2}}$. Determine $A/(B + C)$. Choose the closest answer. *Hint:* Read carefully. This is not asking for $A + B + C$.
A: 5.
B: 2.
C: 1.
D: 4.
E: 3.

Question 11: Suppose $\tilde{x}(t)$ has period $T_0 = 2$ and Fourier series coefficients $x_2 = 2-j$, $x_{-2} = 2+j$, $x_3 = 2j$, and $x_{-3} = -2j$; all other x_ks are zero. Determine the percentage of power in the second harmonic. Choose the closest answer.
A: 55%.
B: 75%.
C: 65%.
D: 70%.
E: 60%.

Question 12: Determine the inverse Fourier transform $x(t)$ if $X(j\omega) = e^{j\omega}\text{rect}(\frac{\omega}{2})$.
The answer has the form $\frac{1}{\pi(t-B)}\sin(A(t-B))$. What is $A+B$? Choose the closest answer.
A: -2.
B: 1.
C: 0.
D: -1.
E: 2.

Answers to Test 301: AEBA CBCB CCCD

Serial Number: **301** Name:

ECE 3300 Spring 2017 (Signals, Systems, and Transforms): Exam III

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Question 1: Determine $x[n]$ if $X(e^{j\omega}) = e^{-2j\omega}(2 - e^{-j\omega})^2$. At what time value n does $x[n] = 1$? *Hint:* First expand the square and recall that $\delta[n]$ has transform 1.
A: 4.
B: 1.
C: 5.
D: 2.
E: 3.

Question 2: Use the definition of the Fourier transform to find the Fourier transform of $x(t) = t^{-3/2}e^{-4/t}e^{-t/4}u(t)$. Use the fact that, if $\text{Re}\{a\} > 0$ and $\text{Re}\{b\} > 0$, $\int_0^\infty t^{-3/2}e^{-a/t}e^{-bt}dt = \sqrt{\frac{\pi}{a}}e^{-2\sqrt{ab}}$. The answer can be written in the form $\frac{\sqrt{\pi}}{A}e^{-2\sqrt{B+Cj\omega}}$. What is $A + B + C$? Choose the closest answer.
A: 8.
B: 9.
C: 6.
D: 10.
E: 7.

Question 3: Suppose $\tilde{x}[n]$ has fundamental cycle $x[n]$ and fundamental period $N_0 = 6$. If the Fourier transform of the fundamental cycle is $X(e^{j\omega}) = 12\cos(\omega) - 24\cos(2\omega)$, determine the Fourier series coefficient x_1. Choose the closest answer.
A: 4.
B: 3.
C: 1.
D: 2.
E: 5.

Question 4: Suppose $x(t)$ is a real, odd signal, and suppose $X(j\omega) = \frac{j\omega(1-\omega^2)}{1+\omega^4}$. For which of the following region(s) does $\angle X(j\omega)$ equal to $-\frac{\pi}{2}$?
A: $-1 < \omega < 0$ and $\omega > 1$.
B: $\omega > 0$.
C: $\omega < -1$ and $0 < \omega < 1$.
D: $\omega < -1$ and $\omega > 1$.
E: $-1 < \omega < 1$.

Question 5: Suppose $\tilde{x}(t)$ has period $T_0 = 4$ and Fourier series coefficients $x_0 = 1$, $x_1 = j$, $x_{-1} = -j$, $x_2 = 1+j$, $x_{-2} = 1-j$, $x_3 = 2j$, $x_{-3} = -2j$, $x_4 = 2$, and $x_{-4} = 2$, with $x_k = 0$ for all other values of k. Determine the percentage of power in the frequency band $[3, 5]$. Choose the closest answer.
A: 30%.
B: 40%.
C: 50%.
D: 70%.
E: 60%.

Question 6: Suppose $|X(e^{j\omega})| = 2$ if $|\omega| < \frac{\pi}{3}$, 1 if $\frac{\pi}{3} \leq |\omega| < \frac{2\pi}{3}$, and 3 if $\frac{2\pi}{3} \leq |\omega| < \pi$. Determine the percentage of energy in the frequency band $(\frac{\pi}{2}, \pi)$. Choose the closest answer.
A: 50%.
B: 70%.
C: 80%.
D: 90%.
E: 60%.

Question 7: Determine the Fourier transform of $e^{-2(t-2)}u(t-1)$. The answer has the form $\frac{e^A e^{Bj\omega}}{C+j\omega}$. What is $A+B+C$? Choose the closest answer. *Hint:* First consider $e^{-2(t-1)}u(t-1)$. Also recall that $e^{a+b} = e^a e^b$.
A: 5.
B: 2.
C: 3.
D: 1.
E: 4.

Question 8: Given that $x[n]$ has Fourier transform $\frac{1}{2-e^{-3j\omega}}$, determine the Fourier transform of $2x[n]\cos(\frac{\pi}{6}n)$. What is the value of this transform at $\omega = 0$? Choose the closest answer.
A: 0.6.
B: 0.8.
C: 0.2.
D: 1.0.
E: 0.4.

Question 9: Suppose $\tilde{x}(t)$ has Fourier transform $3\pi\delta(\omega+6)+4\pi\delta(\omega+4)+5\pi\delta(\omega+2)+5\pi\delta(\omega-2)+4\pi\delta(\omega-4)+3\pi\delta(\omega-6)$. Determine T_0 and the Fourier series coefficient x_2. What is $T_0 + x_2$? Choose the closest answer.
A: 4.
B: 7.
C: 5.
D: 6.
E: 8.

Question 10: Given that $x[n]$ has Fourier transform $\frac{1}{2-e^{-3j\omega}}$, determine the Fourier transform of $nx[n]$. The answer has the form $\frac{A+Be^{-3j\omega}}{(2-e^{-3j\omega})^C}$, where A, B, and C are real. What is $A+B+C$? Choose the closest answer.
A: 1.
B: 2.
C: 5.
D: 4.
E: 3.

Question 11: It can be shown that the Fourier transform of $\frac{t}{\sinh(t)}$ is $\frac{1}{2\pi}\frac{1}{\cosh(\pi\omega/2)}$. Use this fact to determine the Fourier transform of $\int_{-\infty}^{t}\frac{4\tau}{\sinh(\tau)}d\tau$. The answer has the form $\frac{A(j\omega)^B}{2\pi\cosh(\pi\omega/2)}+C\delta(\omega)$. What is $A+B+C$? Choose the closest answer. *Hint:* $\sinh(0)=0$ and $\cosh(0)=1$. You don't need to know anything else about these functions.

A: 1.
B: 2.
C: 5.
D: 3.
E: 4.

Question 12: Suppose $x(t)=2\delta(t)+3e^{-t}u(t)$. Determine the magnitude of the Fourier transform. The answer has the form $|X(j\omega)|=\frac{\sqrt{A+B\omega^2}}{\sqrt{1+C\omega^2}}$. What is $A+B+C$? Choose the closest answer.

A: 15.
B: 10.
C: 25.
D: 30.
E: 20.

Answers: EBAC DDCB ADDE

Serial Number: **401** Name:

ECE 3300 Fall 2015 (Signals, Systems, and Transforms): Exam IV

Record your name on this test; record your name, student ID, and test serial number on the scantron. Enter the test serial number in *COURSE*; you may leave *SECTION* blank. You must show your work on every problem, showing all steps on your test. Do not use scratch paper or write your work anywhere but on the test. The examination lasts 50 minutes and you may use four sheets of notes (front and back); no old test questions can be on your notes. Calculator use is permitted. There is one correct answer per question.

Question 1: Consider a linear time-invariant system such that $h[n] = (n+1)(\frac{1}{2})^n u[n]$. If the input $\tilde{x}[n]$ is periodic with period $N_0 = 8$ and if the input Fourier series coefficient $x_2 = 1 + \frac{1}{2}j$, then determine the output Fourier series coefficient y_2. In rectangular form, $y_2 = a + jb$. What is $a + b$? Choose the closest answer.
A: 0.8.
B: 1.0.
C: 0.6.
D: 0.2.
E: 0.4.

Question 2: Suppose $H(j\omega) = \dfrac{(j\omega)^2(800+j\omega)^2(1600+j\omega)^2(50+j\omega)}{(10+j\omega)(200+j\omega)(400+j\omega)}$. Determine the slope of the Bode plot in the region from $\omega = 400$ to $\omega = 800$.
A: 40 dB/decade.
B: 0 dB/decade.
C: -20 dB/decade.
D: -40 dB/decade.
E: 20 dB/decade.

Question 3: Suppose $H(j\omega) = \dfrac{2(8+j\omega)(40+j\omega)^2(200+j\omega)}{(j\omega)(20+j\omega)(80+j\omega)^2}$. Determine the value of the Bode approximation to $|H(j\omega)|$ at $\omega = 40$. Choose the closest answer.
A: 8 dB.
B: 2 dB.
C: 11 dB.
D: 5 dB.
E: 14 dB.

Question 4: Consider a linear time-invariant system with input $x[n] = (n+3)(-\frac{1}{2})^n u[n]$ and impulse response $h[n] = -(-\frac{1}{3})^n u[n]$. Use Fourier techniques to determine the output $y[n]$. What is $y[1]$? Choose the closest answer. *Hint:* $n+3 = (n+1)+2$.
A: 1.
B: 4.
C: 3.
D: 2.
E: 5.

Question 5: Consider a linear time-invariant system with $h(t) = (5t+1)e^{-t}u(t)$. Determine the group delay $D(\omega)$. The answer has the form $D(\omega) = \frac{A}{B^2+\omega^2} + \frac{C}{D^2+\omega^2}$ where $B > 0$ and $D > 0$. Determine $A+B+C+D$. Choose the closest answer.
A: 5.
B: 2.
C: 4.
D: 3.
E: 1.

Question 6: Consider a linear time-invariant system with $H(e^{j\omega}) = \frac{e^{-2j\omega}}{(1-\frac{1}{2}e^{-j\omega})^2}$. Determine the phase response $\angle H(e^{j\omega})$. The answer has the form $A\omega + B\tan^{-1}(\frac{\sin\omega}{C+D\cos\omega})$. What is $A+B+C+D$? Choose the closest answer.
A: -2.
B: -4.
C: -1.
D: -3.
E: -5.

Question 7: Consider a linear time-invariant system with impulse response $h[n] = \frac{1}{2}(\frac{1}{3})^n u[n] + \frac{1}{2}(\frac{2}{3})^n u[n]$. Determine the magnitude response $|H(e^{j\omega})|$. What is the sum of the values of the magnitude response at $\omega = 0$ and $\omega = \pi$? Choose the closest answer.
A: 2.
B: 1.
C: 3.
D: 5.
E: 4.

Question 8: Consider a linear time-invariant system with input $x(t) = \frac{1}{2}\delta(t) - e^{-3t}u(t)$ and output $y(t) = e^{-3t}u(t)$. Use Fourier techniques to determine the impulse response $h(t)$. The answer has the form $h(t) = Ae^{-Bt}u(t)$. What is $A + B$? Choose the closest answer.
A: 1.
B: 3.
C: 2.
D: 5.
E: 4.

Question 9: Consider the filter with magnitude response $|H(j\omega)| = \frac{100|\omega|}{\omega^2+100}$. Let $A = 0$ if this filer is passive and $A = 1$ if it is active. Let $B = 1$ if this filter is lowpass, $B = 2$ if highpass, $B = 3$ if bandpass, and $B = 4$ if bandstop. What is $A + B$? *Hint:* Evaluate $|H(j\omega)|$ at $\omega = 0$, $\omega = 10$, and $\omega = \infty$.
A: 4.
B: 2.
C: 5.
D: 3.
E: 1.

Question 10: Suppose a Bode plot of $|H(j\omega)|$ is a straight line of slope -40 dB/decade between $\omega = 2000$ and $\omega = 2500$ such that $|H(j2000)| = 12$ dB. What is $|H(j2500)|$? Choose the closest answer.
A: 6 dB.
B: 4 dB.
C: 10 dB.
D: 8 dB.
E: 2 dB.

Question 11: Consider a linear time-invariant system with impulse response $h(t) = e^{-2t}u(t)$ and output $y(t) = e^{-2|t|}$. Determine the required input $x(t)$. The answer has the form $Ae^{Bt}u(-t)$. What is $A + B$? Choose the closest answer. *Hints:* For $a > 0$, $e^{-a|t|}$ has Fourier transform $\frac{2a}{a^2+\omega^2} = \frac{2a}{(a+j\omega)(a-j\omega)}$. Also, recall that if a signal $x(t)$ has Fourier transform $X(j\omega)$, then $x(-t)$ has Fourier transform $X(j(-\omega))$.
A: 4.
B: 3.
C: 5.
D: 6.
E: 2.

Question 12: Suppose we wish to create an ideal bandstop filter with cutoff frequencies $\omega = 10$ and $\omega = 20$. Which one of the following composite systems will accomplish this?

A: None of the other four answers will work.

B: Ideal highpass filter with cutoff $\omega = 10$ in series with ideal lowpass filter with cutoff $\omega = 20$.

C: Ideal lowpass filter with cutoff $\omega = 10$ in series with ideal highpass filter with cutoff $\omega = 20$.

D: Ideal highpass filter with cutoff $\omega = 10$ in parallel with ideal lowpass filter with cutoff $\omega = 20$.

E: Ideal lowpass filter with cutoff $\omega = 10$ in parallel with ideal highpass filter with cutoff $\omega = 20$.

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401 Answers: EEEB DEDC BACB

Serial Number: **401** Name:

ECE 3300 Fall 2016 (Signals, Systems, and Transforms): Exam IV

Record your name on this test; record your name, student ID, and test serial number on the scantron. Enter the test serial number in *COURSE*; you may leave *SECTION* blank. You must show your work on every problem, showing all steps on your test. Do not use scratch paper or write your work anywhere but on the test. Circle your answers on the test and bubble in the corresponding answers on your scantron. The examination lasts 60 minutes and you may use four sheets of notes (front and back); no old test questions can be on your notes. Calculator use is permitted. There is one correct answer per question. In problems asking to find coefficients A, B, C, etc., some of these coefficients may equal zero.

Question 1: Suppose a Bode plot of $|H(j\omega)|$ is a straight line of slope 40 dB/decade between $\omega = 300$ and $\omega = 1200$ such that $|H(j600)| = 0$ dB. What is $|H(j1200)|$? Choose the closest answer.
A: 18 dB.
B: 30 dB.
C: 24 dB.
D: 6 dB.
E: 12 dB.

Question 2: Consider a linear time-invariant system with impulse response $h(t) = (e^{-t} - e^{-3t})u(t)$. Determine the magnitude response.
A: $\frac{1}{\sqrt{1+\omega^2}} - \frac{1}{\sqrt{9+\omega^2}}$.
B: $\frac{1}{\sqrt{1+\omega^2}} + \frac{1}{\sqrt{9+\omega^2}}$.
C: $\frac{2\sqrt{4+\omega^2}}{\sqrt{1+\omega^2}\sqrt{9+\omega^2}}$.
D: $\frac{1}{\sqrt{1+\omega^2}\sqrt{9+\omega^2}}$.
E: $\frac{2}{\sqrt{1+\omega^2}\sqrt{9+\omega^2}}$.

Question 3: Consider a linear time-invariant system with $H(j\omega) = \frac{(2+j\omega)^3}{(1+j\omega)^2(3+j\omega)}$. Determine the phase response $\angle H(j\omega)$. The answer has the form $A\tan^{-1}(\frac{\omega}{B}) + C\tan^{-1}(\frac{\omega}{D}) + E\tan^{-1}(\frac{\omega}{F})$, where $B > 0$, $D > 0$, and $F > 0$. What is $A + B + C + D + E + F$? Choose the closest answer.
A: 7.
B: 8.
C: 9.
D: 10.
E: 6.

Question 4: Consider a linear time-invariant system with impulse response $h[n] = (\frac{2}{3})^n u[n]$ and output $y[n] = (\frac{1}{3})^n u[n]$. Use Fourier techniques to determine the input $x[n]$. The answer has the form $A\delta[n] + B(\frac{1}{C})^n u[n]$. What is $A + B + C$? Choose the closest answer.
A: 5.
B: 4.
C: 1.
D: 2.
E: 3.

Question 5: Suppose $H(j\omega) = \dfrac{(10+j\omega)^3(100+j\omega)(50+j\omega)}{(j\omega)^2(200+j\omega)^2(250+j\omega)^2}$. Determine the slope of the Bode plot in the region from $\omega = 100$ to $\omega = 200$.
A: 0 dB/decade.
B: 40 dB/decade.
C: 20 dB/decade.
D: 60 dB/decade.
E: 80 dB/decade.

Question 6: Suppose $H(j\omega) = \dfrac{j\omega(80+j\omega)^3}{(20+j\omega)(40+j\omega)^2(160+j\omega)}$. Determine the value of the Bode approximation to $|H(j\omega)|$ at $\omega = 40$. Choose the closest answer.
A: 15 dB.
B: 9 dB.
C: 3 dB.
D: 12 dB.
E: 6 dB.

Question 7: Consider a linear time-invariant system with impulse response $h(t) = \frac{2}{\sqrt{t}}e^{-3t}u(t)$ and input $x(t) = e^{-3t}u(t)$. Determine the output $y(t)$. You may use without proof the facts that, if $a > 0$, $\sqrt{t}e^{-at}u(t)$ has Fourier transform $\frac{\sqrt{\pi}}{2}\frac{1}{(a+j\omega)^{3/2}}$ and $\frac{1}{\sqrt{t}}e^{-at}u(t)$ has Fourier transform $\frac{\sqrt{\pi}}{(a+j\omega)^{1/2}}$. Determine the output $y(t)$. The answer has the form $(A+B\sqrt{t}+Ct)e^{-Dt}u(t)$. What is $A+B+C+D$? Choose the closest answer.
A: 6.
B: 10.
C: 9.
D: 7.
E: 8.

Question 8: Consider the filter with magnitude response $|H(j\omega)| = \frac{(1+j\omega)(100+j\omega)}{(10+j\omega)^2}$. Let $A = 0$ if this filer is passive and $A = 1$ if it is active. Let $B = 1$ if this filter is lowpass, $B = 2$ if highpass, $B = 3$ if bandpass, and $B = 4$ if bandstop. What is $A + B$? *Hint:* Look at the Bode plot.
A: 5.
B: 1.
C: 4.
D: 2.
E: 3.

Question 9: Consider a linear time-invariant system with $H(e^{j\omega}) = \frac{1-\frac{1}{2}e^{-j\omega}}{(1-\frac{3}{4}e^{-j\omega})^2}$. Determine group delay $D(\omega)$. What is $D(0)$? Choose the closest answer.
A: 4.
B: 5.
C: 1.
D: 3.
E: 2.

Question 10: Consider a linear time-invariant system with input $x(t) = 5\delta(t) - 4e^{-2t}u(t)$ and output $y(t) = e^{-t}u(t) + 4e^{-2t}u(t)$. Use Fourier techniques to determine the impulse response $h(t)$. The answer has the form $h(t) = A\delta(t)+Be^{-Ct}u(t)$. What is $A+B+C$? Choose the closest answer.
A: 2.
B: 1.
C: 5.
D: 3.
E: 4.

Question 11: Consider the low-pass system with frequency response $H(j\omega) = \begin{cases} 10 & \text{if } |\omega| \leq 25 \\ 10e^{-(|\omega|-25)/10} & \text{if } |\omega| > 25 \end{cases}$. Determine the roll-off ratio. Assume the passband attenuation level is 90% of peak and the the stopband attenuation level is 10% of peak. Choose the closest answer.

A: 1.6.
B: 2.0.
C: 1.8.
D: 1.2.
E: 1.4.

Question 12: Consider a linear time-invariant system such that $H(e^{j\omega}) = \frac{4}{5-4\cos^2(\omega)}$. If the input $\tilde{x}[n]$ is periodic with period $N_0 = 6$ and Fourier series coefficients $x_k = \frac{4}{4-|k|}$ for $-3 \leq k \leq 2$ (and x_ks are periodic with period 6) then determine the output Fourier series coefficients y_0 and y_2. What is $y_0 + y_2$? Choose the closest answer.

A: 10.
B: 6.
C: 8.
D: 2.
E: 4.

Answers: EBED EADD AEDB

Note: Problem 1 has been modified here to give a valid answer. In the original test, the problem was not solvable.

Serial Number: **401** Name:

ECE 3300 Spring 2016 (Signals, Systems, and Transforms): Exam IV

Record your name on this test; record your name, student ID, and test serial number on the scantron. Enter the test serial number in *COURSE*; you may leave *SECTION* blank. You must show your work on every problem, showing all steps on your test. Do not use scratch paper or write your work anywhere but on the test. The examination lasts 50 minutes and you may use four sheets of notes (front and back); no old test questions can be on your notes. Calculator use is permitted. There is one correct answer per question. In problems asking to find coefficients A, B, C, etc., some of these coefficients may equal zero.

Question 1: Consider a linear time-invariant system with input $x[n] = \delta[n] - \frac{3}{5}(\frac{1}{5})^n u[n]$ and impulse response $h[n] = \frac{7}{2}(\frac{1}{2})^n u[n] - \delta[n]$. Use Fourier techniques to determine the output $y[n]$. The answer has the form $A\delta[n] + B(\frac{1}{5})^n u[n]$. What is $A + B$? Choose the closest answer.
A: 2.
B: 4.
C: 3.
D: 5.
E: 1.

Question 2: Consider a linear time-invariant system with $H(j\omega) = \frac{(3+j\omega)(-1+j\omega)}{(1+j\omega)^2}$. Determine the group delay $D(\omega)$. What is $D(1)$? Choose the closest answer.
A: 0.9.
B: 1.2.
C: 1.5.
D: 0.3.
E: 0.6.

Question 3: Consider a linear time-invariant system with impulse response $h(t) = (1+2t)e^{-t}u(t)$ and output $y(t) = te^{-t}u(t)$. Use Fourier techniques to determine the input $x(t)$. The answer has the form $x(t) = Ae^{-Bt}u(t)$. What is $A + B$? Choose the closest answer.
A: 2.
B: 1.
C: 3.
D: 5.
E: 4.

Question 4: Consider the filter with magnitude response $|H(e^{j\omega})| = \frac{2|\sin(\omega)|}{2-\cos^2(\omega)}$. Let $A = 0$ if this filer is passive and $A = 1$ if it is active. Let $B = 1$ if this filter is lowpass, $B = 2$ if highpass, $B = 3$ if bandpass, and $B = 4$ if bandstop. What is $A + B$? *Hint:* Evaluate $|H(e^{j\omega})|$ at multiples of $\frac{\pi}{2}$.
A: 4.
B: 1.
C: 2.
D: 3.
E: 5.

Question 5: Consider a linear time-invariant system with $H(e^{j\omega}) = (1 - e^{-j\omega})(1 + 2e^{-j\omega})$. Determine the phase response $\angle H(e^{j\omega})$. The answer has the form $\tan^{-1}(\frac{A\sin\omega}{1-B\cos\omega}) + \tan^{-1}(\frac{C\sin\omega}{1-D\cos\omega})$. What is $A+B+C+D$? Choose the closest answer.
A: -3.
B: -4.
C: 0.
D: -1.
E: -2.

Question 6: Suppose a Bode plot of $|H(j\omega)|$ is a straight line of slope -20 dB/decade between $\omega = 800$ and $\omega = 5000$ such that $|H(j1000)| = 26$ dB. What is $|H(j2500)|$? Choose the closest answer.
A: 18 dB.
B: 9 dB.
C: 12 dB.
D: 6 dB.
E: 15 dB.

Question 7: Suppose $H(j\omega) = \dfrac{(10+j\omega)(50+j\omega)^3(150+j\omega)}{(100+j\omega)^2(250+j\omega)^2(75+j\omega)}$. Determine the slope of the Bode plot in the region from $\omega = 100$ to $\omega = 150$.
A: 40 dB/decade.
B: -20 dB/decade.
C: -40 dB/decade.
D: 20 dB/decade.
E: 0 dB/decade.

Question 8: Suppose $H(j\omega) = \dfrac{20(5+j\omega)^2(100+j\omega)^2(250+j\omega)}{(j\omega)^3(40+j\omega)(200+j\omega)}$. Determine the value of the Bode approximation to $|H(j\omega)|$ at $\omega = 100$. Choose the closest answer.
A: 31 dB.
B: 34 dB.
C: 37 dB.
D: 28 dB.
E: 25 dB.

Question 9: Consider a linear time-invariant system such that $H(j\omega) = \frac{2}{1+\omega^2}$. If the input $\tilde{x}(t)$ is periodic with period $T_0 = 4\pi$ and Fourier series coefficients $x_k = \frac{25}{4}(\frac{2}{5})^{|k|}$, then determine the output Fourier series coefficients y_1 and y_2. What is $y_1 + y_2$? Choose the closest answer.
A: 5.
B: 2.
C: 1.
D: 4.
E: 3.

Question 10: Consider a linear time-invariant system with impulse response $h(t) = (1+at)e^{-2t}u(t)$. Determine a if the magnitude response is $|H(j\omega)| = \frac{\sqrt{16+\omega^2}}{4+\omega^2}$. Choose the closest answer.
A: 5.
B: 1.
C: 4.
D: 3.
E: 2.

Question 11: Suppose $H(j\omega) = \frac{100(j\omega)(20+j\omega)}{(2+j\omega)^2}$. Determine the value of the Bode phase plot at $\omega = 2$. Choose the closest answer.
A: $\pi/4$.
B: $-\pi/2$.
C: $-\pi/4$.
D: 0.
E: $\pi/2$.

Question 12: Consider a linear time-invariant system with impulse response $h(t) = \frac{2}{\pi t}\sin(2t)$ and input $x(t) = \frac{1}{\pi t}\sin(t) + \frac{3}{\pi t}\sin(3t)$. Determine the output $y(t)$. The answer has the form $\frac{A}{\pi t}\sin(Bt) + \frac{C}{\pi t}\sin(Dt)$. What is $A + B + C + D$? Choose the closest answer.
A: 8.
B: 11.
C: 10.
D: 9.
E: 12.

Answers: EDBB CEBE AEAE

(For Problem 3 the equation in the question was not as intended. This key shows the question as it was intended. For the original question the filter was lowpass.)

Serial Number: **401** Name:

ECE 3300 Spring 2017 (Signals, Systems, and Transforms): Exam IV

Record your name on this test; record your name, student ID, and test serial number on the scantron. Enter the test serial number in *COURSE*; you may leave *SECTION* blank. You must show your work on every problem, showing all steps on your test. Do not use scratch paper or write your work anywhere but on the test. Circle your answers on the test and bubble in the corresponding answers on your scantron. The examination lasts 60 minutes and you may use four sheets of notes (front and back); no old test questions can be on your notes. Calculator use is permitted. There is one correct answer per question. In problems asking to find coefficients A, B, C, etc., some of these coefficients may equal zero.

Question 1: Consider the high-pass system with frequency response $H(j\omega) = \frac{20\omega^4}{\omega^4+256}$. Determine the roll-off ratio. Assume the passband attenuation level is 90% of peak and the the stopband attenuation level is 10% of peak. Choose the closest answer. *Hint:* The peak occurs as $\omega \to \infty$.
A: 1.
B: 5.
C: 2.
D: 4.
E: 3.

Question 2: Consider a linear time-invariant system with impulse response $h[n] = (-\frac{1}{2})^n u[n] + 2\delta[n]$. Determine the magnitude response. What is the value of the magnitude response at $\omega = -\pi$? Choose the closest answer.
A: 2.
B: 5.
C: 1.
D: 4.
E: 3.

Question 3: Consider the filter with magnitude response $H(j\omega) = \frac{(1500+j\omega)^2(4500+j\omega)^2}{(100+j\omega)(500+j\omega)(13500+j\omega)^2}$. Which description below is most accurate? *Hint:* Look at the Bode plot.
A: Bandpass with the frequency "passband" roughly centered at $\omega = 9000$.
B: Bandstop with the frequency "stopband" roughly centered at $\omega = 3000$.
C: Lowpass with the cutoff frequency roughly around $\omega = 6000$.
D: Bandpass with the frequency "passband" roughly centered at $\omega = 3000$.
E: Bandstop with the frequency "stopband" roughly centered at $\omega = 9000$.

Question 4: Suppose a Bode plot of $|H(j\omega)|$ is a straight line of slope -20 dB/decade between $\omega = 80$ and $\omega = 400$ such that $|H(j80)| = 22$ dB. What is $|H(j400)|$? Choose the closest answer.
A: 6 dB.
B: 8 dB.
C: 4 dB.
D: 2 dB.
E: 10 dB.

Question 5: Consider a linear time-invariant system with impulse response $h[n] = 2\delta[n] - 4\delta[n-1]$. Determine the phase response $\angle H(e^{j\omega})$. The answer has the form $A\tan^{-1}(\frac{B\sin\omega}{1-C\cos\omega})$, where $A > 0$, $B > 0$, and $C > 0$. What is $A + B + C$? Choose the closest answer.
A: 7.
B: 8.
C: 5.
D: 6.
E: 9.

Question 6: Consider a linear time-invariant system with input $x[n] = 3(\frac{1}{2})^n u[n] - 2(\frac{1}{3})^n u[n]$ and impulse response $h[n] = \delta[n] - \frac{1}{3}\delta[n-1]$. Use Fourier techniques to determine the output $y[n]$. The answer has the form $A\delta[n] + B(\frac{1}{C})^n u[n]$. What is $A + B + C$? Choose the closest answer.
A: 2.
B: 1.
C: 4.
D: 5.
E: 3.

Question 7: Consider a linear time-invariant system such that $H(j\omega) = \frac{5}{1+\omega^2}$. If the input $\tilde{x}(t)$ is periodic with period $T_0 = 4\pi$ and Fourier series coefficients $x_k = (\frac{1}{2})^{|k|}$, determine the output Fourier series coefficient y_1. Choose the closest answer.
A: 4.
B: 2.
C: 3.
D: 5.
E: 1.

Question 8: Consider a linear time-invariant system with $H(j\omega) = \frac{3+j\omega}{(2+j\omega)^3}$. Determine group delay $D(\omega)$. What is $D(0)$? The answer has the form A/B, where A and B are positive integers and the fraction A/B is as simplified as possible. (For example, $\frac{6}{4}$ would be simplified to $\frac{3}{2}$.) What is $A + B$? Choose the closest answer.
A: 7.
B: 11.
C: 5.
D: 9.
E: 13.

Question 9: Consider a linear time-invariant system with input $x(t) = (1 + 3t)e^{-2t}u(t)$ and output $y(t) = (1 - 2t)e^{-2t}u(t)$. Use Fourier techniques to determine the impulse response $h(t)$. The answer has the form $h(t) = A\delta(t) + Be^{-Ct}u(t)$. What is $A + B + C$? Choose the closest answer.
A: 1.
B: 2.
C: 4.
D: 5.
E: 3.

Question 10: Suppose $H(j\omega) = \dfrac{10^4(500 + j\omega)^2(50 + j\omega)}{j\omega(100 + j\omega)(1000 + j\omega)^2}$. Determine the value of the Bode straight-line approximation to $|H(j\omega)|$ at $\omega = 500$. Choose the closest answer.
A: 8 dB.
B: 20 dB.
C: 26 dB.
D: 2 dB.
E: 14 dB.

Question 11: Suppose $H(j\omega) = \dfrac{(10+j\omega)^3(1000+j\omega)(500+j\omega)}{(j\omega)(200+j\omega)(50+j\omega)^2}$. Determine the slope of the Bode plot in the region from $\omega = 200$ to $\omega = 500$.
A: -20 dB/decade.
B: -40 dB/decade.
C: 40 dB/decade.
D: 20 dB/decade.
E: 0 dB/decade.

Question 12: Consider a linear time-invariant system with impulse response $h(t) = \frac{1}{\pi t}(\sin(4t) - \sin(2t))$ and input $x(t) = \frac{1}{\pi t}\sin(3t)$. Use Fourier techniques to determine the output. The answer has the form $y(t) = \frac{1}{\pi t}(\sin(At) - \sin(Bt))$. What is $A + B$? Choose the closest answer. *Hint:* Recall that, if $a > 0$, $\frac{1}{\pi t}\sin(at)$ has Fourier transform $\mathrm{rect}(\frac{\omega}{2a})$.
A: 7.
B: 9.
C: 8.
D: 6.
E: 5.

Answers: EEEC DEDC BACB

Serial Number: **501** Name:

ECE 3300 Fall 2015 (Signals, Systems, and Transforms): Exam V

Record your name on this test; record your name, student ID, and test serial number on the scantron. Enter the test serial number in *COURSE*; you may leave *SECTION* blank. You must show your work on every problem, showing all steps on your test. Do not use scratch paper or write your work anywhere but on the test. The examination lasts 50 minutes and you may use five sheets of notes (front and back); no old test questions can be on your notes. Calculator use is permitted. There is one correct answer per question.

Question 1: Suppose $x(t) = e^{-t}(\cos(2t) - 2\sin(2t))u(t)$. Determine $X(s)$. The answer has the form $\frac{As+B}{s^2+Cs+D}$. Determine $A+B+C+D$. Choose the closest answer. You do not need to determine the ROC.
A: 3.
B: 1.
C: 4.
D: 2.
E: 5.

Question 2: Given that $J_0(t)u(t)$ has Laplace transform $\frac{1}{\sqrt{s^2+1}}$, and given that $\frac{d}{dt}[J_0(t)u(t)] = \delta(t) - J_1(t)u(t)$, determine the Laplace transform of $J_1(t)u(t)$. The answer has the form $A + \frac{Bs+C}{\sqrt{s^2+1}}$. Determine $A+B+C$. Choose the closest answer.
A: -2.
B: 1.
C: 2.
D: -1.
E: 0.

Question 3: Suppose the signal $x[n]$ has Z transform $X(z) = \frac{1}{(1+4z^{-4})^2}$. Suppose $Y(z) = \frac{1}{1+4z^{-4}}$ with the same ROC as that of $X(z)$. Express $y[n]$ as a function of $x[n]$. *Hint:* First find $Y(z)$ as a function of $X(z)$.
A: $y[n] = (-4)^n x[n]$.
B: $y[n] = (-\frac{1}{4})^n x[n]$.
C: $y[n] = [(-\frac{1}{4})^n]^4 x[n]$.
D: $y[n] = \sqrt{x[n]}$.
E: $y[n] = x[n] + 4x[n-4]$.

Question 4: Determine the Laplace transform of $(1+t)\sin(t)u(t)$. You may use without proof the fact that $\sin(at)u(t)$ has Laplace transform $\frac{a}{s^2+a^2}$. The answer has the form $\frac{As^3+Bs^2+Cs+D}{s^4+Es^3+Fs^2+Gs+H}$. What is $A+B+C+D+E+F+G+H$? Choose the closest answer. You do not need to consider ROCs in this problem.
A: 10.
B: 6.
C: 7.
D: 9.
E: 8.

Question 5: Suppose $X(z) = 1 + \frac{1}{1-z^{-1}} + \frac{1}{1+z^{-1}} + \frac{1}{(1-z^{-1})^2} + \frac{1}{1-2z^{-1}} + \frac{1}{1+2z^{-1}}$. If the ROC is $1 < |z| < 2$, determine $x[n]$. What is $x[1]$? Choose the closest answer.
A: 3.
B: 1.
C: 0.
D: 2.
E: 4.

Question 6: Suppose $X(s) = \frac{s^2}{(s+1)^3}$. The partial fraction expansion has the form $\frac{A}{s+1} + \frac{B}{(s+1)^2} + \frac{C}{(s+1)^3}$. Determine B. Choose the closest answer.
A: 2.
B: 0.
C: -1.
D: 1.
E: -2.

Question 7: Suppose a signal $x[n]$ has Z transform $\frac{1}{1+z^{-4}}$. Determine the Z transform of $y[n] = (-1)^n x[n-1]$. The answer has the form $Y(s) = \frac{Az^B}{1+Cz^{-4}}$. What is $A+B+C$? Choose the closest answer. You do not need to determine the ROC.
A: -2.
B: -4.
C: -5.
D: -1.
E: -3.

Question 8: Suppose $X(z) = \dfrac{8z^{-1}(1-z^{-1})}{(1-2z^{-1})^2}$ with ROC $|z| > 2$. It follows that $x[n] = a\delta[n] + (bn+c)2^n u[n]$. What is $a+b+c$? Choose the closest answer.
A: -2.
B: 1.
C: 2.
D: 0.
E: -1.

Question 9: Suppose $x(t)$ has Laplace transform $X(s)$ with ROC $1 < \text{Re}\{s\} < 9$ and $y(t) = (e^{2t} + e^{-t})^2 x(t)$. Determine the ROC for $Y(s)$. The answer has the form $a < \text{Re}\{s\} < b$. What is $b - a$? Choose the closest answer. *Hint:* Expand the square.
A: 4.
B: 2.
C: 10.
D: 6.
E: 8.

Question 10: Suppose $x[n] = (\frac{1}{2})^{|n|} + (-\frac{1}{3})^{|n|}$. Determine the ROC for $X(z)$. *Hint:* $a^{|n|} = a^n u[n] + a^{-n} u[-n-1]$.
A: $\frac{1}{2} < |z| < 2$.
B: $\frac{1}{3} < |z| < 2$.
C: $\frac{1}{2} < |z| < 3$.
D: $-\frac{1}{3} < |z| < \frac{1}{2}$.
E: $\frac{1}{3} < |z| < 3$.

Question 11: Suppose $x[n] = (-2)^n u[-n-1] + (-1)^n u[n] + (\frac{3}{2})^n u[-n-1]$. Which statement is correct?
A: Neither the Z transform nor the Fourier transform exists.
B: The Z and Fourier transforms exist and $X(e^{j\omega})$ can be found by substituting $z = e^{j\omega}$ in $X(z)$.
C: The Z and Fourier transforms exist but $X(e^{j\omega})$ can not be found by substituting $z = e^{j\omega}$ in $X(z)$.
D: The Z transform exists but the Fourier transform does not.
E: The Fourier transform exists but the Z transform does not.

Question 12: Suppose $X(z) = \frac{2+3z^{-1}}{1-2z^{-1}+4z^{-2}}$. For one of the ROCs the inverse Z transform has the form $(A\cos(bn) + B\sin(bn))a^n u[n]$. What is $a + b$, where $0 \leq b \leq \pi$ and $a > 0$? Choose the closest answer.
A: 1.
B: 3.
C: 2.
D: 5.
E: 4.

Answers: CDAB EEDD CBBE

Serial Number: **501** Name:

ECE 3300 Fall 2016 (Signals, Systems, and Transforms): Exam V

Record your name on this test; record your name, student ID, and test serial number on the scantron. Enter the test serial number in *COURSE*; you may leave *SECTION* blank. You must show your work on every problem, showing all steps on your test. Do not use scratch paper or write your work anywhere but on the test. Circle your answers on the test and bubble in the corresponding answers on your scantron. The examination lasts 60 minutes and you may use five sheets of notes (front and back); no old test questions can be on your notes. Calculator use is permitted. There is one correct answer per question. In problems asking to find coefficients A, B, C, etc., some of these coefficients may equal zero.

Question 1: Suppose $x[n]$ has Z transform $X(z) = \frac{1}{(1-\frac{1}{2}z^{-1})^3(1-3z^{-1})^3}$ with ROC $\frac{1}{2} < |z| < 3$. Suppose $y[n] = x[n] + x[-n]$. Determine the ROC for $y[n]$. You do not need to determine $Y(z)$.
A: $2 < |z| < 3$.
B: $\frac{1}{3} < |z| < 3$.
C: $\frac{1}{2} < |z| < 2$.
D: $\frac{1}{2} < |z| < 3$.
E: $\frac{1}{3} < |z| < 2$.

Question 2: Suppose $x[n] = (-\frac{1}{3})^n u[-n-1] + (-\frac{2}{3})^n u[-n-1]$. Determine the ROC for $X(z)$.
A: $-\frac{1}{3} < |z| < \frac{1}{3}$.
B: $|z| < -\frac{1}{3}$.
C: $|z| < \frac{2}{3}$.
D: $|z| < \frac{1}{3}$.
E: $|z| < -\frac{2}{3}$.

Question 3: The signal $x(t) = J_0(t)u(t)$ has Laplace transform $X(s) = \frac{1}{\sqrt{1+s^2}}$ with ROC $\text{Re}\{s\} > 0$. (The signal is a Bessel function but you don't need to know anything about Bessel functions to solve this problem.) Determine the inverse Laplace transform of $Y(s) = \frac{e^{-2s}}{\sqrt{1+(s+1)^2}}$ with ROC $\text{Re}\{s\} > -1$. The answer has the form $x(t) = e^{A(t-B)}J_0(t-C)u(t-D)$. What is $A+B+C+D$? Choose the closest answer. *Hint:* First determine the inverse Laplace transform of $\frac{1}{\sqrt{1+(s+1)^2}}$.
A: 5.
B: 4.
C: 2.
D: 1.
E: 3.

Question 4: Suppose a signal $x[n]$ has Z transform $X(z) = \frac{z}{z^3-1}$. Suppose $y[n] = nx[n]$. Determine $Y(z)$. The answer has the form $\frac{A(z)^B+C(z)^D}{(z^3-1)^2}$. What is $A+B+C+D$? Choose the closest answer. You do not need to determine the ROC.
A: 2.
B: 8.
C: 6.
D: 10.
E: 4.

Question 5: Suppose $x(t)$ has Laplace transform $X(s) = \frac{s+1}{s^2-4s+5}$ with ROC $\text{Re}\{s\} > 2$. Determine the Laplace transform of $e^{-t}x(t)$ including the ROC. The transform has the form $\frac{As+B}{s^2+Cs+D}$ and the ROC has the form $\text{Re}\{s\} > E$. What is $A+B+C+D+E$? Choose the closest answer.
A: 5.
B: 2.
C: 1.
D: 3.
E: 4.

Question 6: Suppose $X(z) = \frac{1}{1+z^{-1}} + \frac{2}{1+2z^{-1}} + \frac{3}{1-z^{-1}} + \frac{4}{1-2z^{-1}}$. If the ROC is $1 < |z| < 2$, determine $x[n]$. The answer has the form $A(B)^n u[n] + C(D)^n u[n] + E(F)^n u[-n-1] + G(H)^n u[-n-1]$. What is $A+B+C+D+E+F+G+H$? Choose the closest answer.
A: -3.
B: -1.
C: -4.
D: 0.
E: -2.

Question 7: Suppose $X(z) = \frac{3-z^{-1}}{(1-\frac{1}{2}z^{-1})^2}$ with ROC $|z| > \frac{1}{2}$. It follows that $x[n] = (An+B)(\frac{1}{2})^n u[n]$. Determine B. Choose the closest answer. *Hint:* Note that $x[n] = (A(n+1) + (B-A))(\frac{1}{2})^n u[n]$.
A: 2.
B: 5.
C: 1.
D: 3.
E: 4.

Question 8: Suppose $X(s) = \dfrac{4(s+2)^3}{(s+1)(s+3)^2}$ with ROC $\text{Re}\{s\} > -1$. It follows that $x(t) = A\delta(t) + Be^{-t}u(t) + (C + Dt)e^{-3t}u(t)$. What is C? Choose the closest answer.
A: -3.
B: -4.
C: -2.
D: -5.
E: -1.

Question 9: Suppose the signal $x[n]$ has Z transform $X(z) = \frac{(\frac{3}{2}+z^{-1})^2}{(\frac{5}{4}-\frac{1}{2}z^{-1})^3}$. with ROC $|z| > \frac{2}{5}$. Suppose $y[n] = \sum_{m=-\infty}^{n} x[m]$. Determine $Y(z)$. What is $Y(2)$? Choose the closest answer. You do not need to determine the ROC in this problem.
A: 10.
B: 9.
C: 8.
D: 7.
E: 6.

Question 10: Suppose $x[n] = (-2)^n u[-n-1] + (-1)^n u[-n-1]$. Which statement is correct?
A: The Z transform exists but the Fourier transform does not.
B: The Z and Fourier transforms exist but $X(e^{j\omega})$ can not be found by substituting $z = e^{j\omega}$ in $X(z)$.
C: The Z and Fourier transforms exist and $X(e^{j\omega})$ can be found by substituting $z = e^{j\omega}$ in $X(z)$.
D: The Fourier transform exists but the Z transform does not.
E: Neither the Z transform nor the Fourier transform exists.

Question 11: Suppose $x(t) = e^{-t}\cos(2t)u(t) - 3e^{-t}\sin(2t)u(t)$. Determine $X(s)$. The answer has the form $\frac{A+Bs}{s^2+Cs+D}$. Determine $A+B+C+D$. Choose the closest answer. You do not need to determine the ROC.
A: 1.
B: 3.
C: 4.
D: 2.
E: 5.

Question 12: Suppose $X(z) = \frac{1-\frac{1}{3}z^{-1}}{1-\frac{2}{3}z^{-1}+\frac{4}{9}z^{-2}}$ with ROC $|z| > \frac{2}{3}$. Determine $x[n]$. The answer has the form $a^n(A\cos(bn) + B\sin(bn))u[n]$ where $0 < b < \pi$. What is $a\sin(b)$? Choose the closest answer.
A: $1/3$.
B: $\sqrt{2}/3$.
C: $\sqrt{5}/3$.
D: $2/3$.
E: $\sqrt{3}/3$.

Answers: BCBD BEDE ADBB

Serial Number: **501** Name:

ECE 3300 Spring 2016 (Signals, Systems, and Transforms): Exam V

Record your name on this test; record your name, student ID, and test serial number on the scantron. Enter the test serial number in *COURSE*; you may leave *SECTION* blank. You must show your work on every problem, showing all steps on your test. Do not use scratch paper or write your work anywhere but on the test. The examination lasts 50 minutes and you may use five sheets of notes (front and back); no old test questions can be on your notes. Calculator use is permitted. There is one correct answer per question. In problems asking to find coefficients A, B, C, etc., some of these coefficients may equal zero.

Question 1: Suppose $X(z) = \dfrac{4z^{-3}}{(1-z^{-1})(1-2z^{-1})}$ with ROC $|z| > 2$. It follows that $x[n] = A\delta[n] + B\delta[n-1] + Cu[n] + D2^n u[n]$. What is A? Choose the closest answer.
A: 5.
B: 3.
C: 4.
D: 2.
E: 1.

Question 2: Suppose $X(s) = \frac{1}{s+1} + \frac{1}{s-1} + \frac{1}{s^2+1}$. If the ROC is $-1 < \text{Re}\{s\} < 0$, determine $x(t)$. The answer has the form $Ae^{-t}u(Bt) + Ce^{t}u(Dt) + E\sin(t)u(Ft)$ where each of A through F are 1 or -1. What is $A+B+C+D+E+F$? Choose the closest answer.
A: -4.
B: 4.
C: -2.
D: 0.
E: 2.

Question 3: Suppose $x(t) = 2tu(-t) + te^{t}u(-t) + te^{-t}u(t) + te^{2t}u(-t)$. Determine the ROC for $X(s)$.
A: $0 < \text{Re}\{s\} < 1$.
B: $-1 < \text{Re}\{s\} < 0$.
C: $-2 < \text{Re}\{s\} < 1$.
D: $1 < \text{Re}\{s\} < 2$.
E: $-2 < \text{Re}\{s\} < -1$.

Question 4: Suppose $X(s) = \frac{-2-s^3}{s(s+1)^2}$. The partial fraction expansion has the form $A + \frac{B}{s} + \frac{C}{s+1} + \frac{D}{(s+1)^2}$. Determine C. Choose the closest answer.
A: 5.
B: 1.
C: 3.
D: 4.
E: 2.

Question 5: Suppose $x[n]$ has Z transform $X(z) = \frac{2+z}{z^3-2z+8}$. Determine the Z transform of $(-\frac{1}{2})^n x[n]$. The answer has the form $\frac{1+Az}{B+Cz+Dz^2+Ez^3}$. What is $A+B+C+D+E$? Choose the closest answer. You do not need to determine an ROC in this problem.
A: -1.
B: 1.
C: 0.
D: -2.
E: 2.

Question 6: Suppose $x[n]$ has Z transform $X(z)$ with ROC $|z| < 2$, $y[n] = x[-n]$, and $w[n] = \sum_{m=-\infty}^{n} y[m]$. Determine the ROC for the Z transform of $w[n]$.
A: $|z| > 2$.
B: $|z| < \frac{1}{2}$.
C: $\frac{1}{2} < |z| < 1$.
D: $1 < |z| < 2$.
E: $|z| > 1$.

Question 7: Suppose $x(t) = e^{-2t}u(t) + e^{-t}u(-t)$. Which statement is correct?
A: The Fourier transform exists but the Laplace transform does not.
B: The Laplace and Fourier transforms exist but $X(j\omega)$ can not be found by substituting $s = j\omega$ in $X(s)$.
C: Neither the Laplace transform nor the Fourier transform exists.
D: The Laplace transform exists but the Fourier transform does not.
E: The Laplace and Fourier transforms exist and $X(j\omega)$ can be found by substituting $s = j\omega$ in $X(s)$.

Question 8: Suppose the signal $x[n] = 3n^2(\frac{1}{3})^n u[n]$ has Z transform $X(z)$. Further suppose $Y(z) = (3z^{-2} - 1)X(z)$. Determine $y[n]$. What is $y[3]$? Choose the closest answer. *Hint:* Use properties. Do not determine $X(z)$ and $Y(z)$ but instead determine a formula for $y[n]$ in terms of $x[n]$.
A: 3.
B: 4.
C: 1.
D: 5.
E: 2.

Question 9: Suppose $x[n] = (-\sqrt{2})^n(\cos(\frac{\pi}{4}n) + \sin(\frac{\pi}{4}n))u[n]$. Determine $X(z)$. The answer has the form $\frac{1+Az^{-1}}{1+Bz^{-1}+Cz^{-2}}$. Determine $A + B + C$. Choose the closest answer. You do not need to determine the ROC.
A: 4.
B: 2.
C: 0.
D: 3.
E: 1.

Question 10: Suppose $X(s) = \frac{2s+3}{(s+2)^2+1}$ with ROC $\text{Re}\{s\} > -2$. Determine $x(t)$. The answer has the form $e^{-at}(A\cos(bt) + B\sin(bt))u(t)$ where $b > 0$. What is $A + B + a + b$? Choose the closest answer.
A: 3.
B: 6.
C: 2.
D: 4.
E: 5.

Question 11: Suppose a signal $x(t)$ has Laplace transform $X(s) = \frac{s}{\sqrt{1+s^2}}$. Suppose $y(t) = 2tx(t)$. Determine $Y(s)$. What is $Y(0)$? Choose the closest answer. You do not need to determine the ROC.
A: 1.
B: -2.
C: -1.
D: 2.
E: 0.

Question 12: Given that $t\cos(t)u(t)$ has Laplace transform $\frac{s^2-1}{(s^2+1)^2}$ with ROC $\text{Re}\{s\} > 0$ determine the inverse Laplace transform of $\frac{s(s^2-1)}{(s^2+1)^2}$ with ROC $\text{Re}\{s\} > 0$. The answer has the form $(A + Bt)\cos(t)u(t) + (C + Dt)\sin(t)u(t)$. Determine $A + B + C + D$. Choose the closest answer.
A: 2.
B: 0.
C: 1.
D: -1.
E: -2.

Answers: EBEA DBBA DACA

Serial Number: **501** Name:

ECE 3300 Spring 2017 (Signals, Systems, and Transforms): Exam V

Record your name on this test; record your name, student ID, and test serial number on the scantron. Enter the test serial number in *COURSE*; you may leave *SECTION* blank. You must show your work on every problem, showing all steps on your test. Do not use scratch paper or write your work anywhere but on the test. Circle your answers on the test and bubble in the corresponding answers on your scantron. The examination lasts 60 minutes and you may use five sheets of notes (front and back); no old test questions can be on your notes. Calculator use is permitted. There is one correct answer per question. In problems asking to find coefficients A, B, C, etc., some of these coefficients may equal zero.

Question 1: Suppose $x(t) = e^t(e^t + e^{-t})^2 u(-t)$. Determine the ROC for $X(s)$. The answer has the form $\text{Re}\{s\} < A$. What is A? Choose the closest answer. *Hint:* First expand the square.
A: 1.
B: 5.
C: 3.
D: -3.
E: -1.

Question 2: Suppose $x[n]$ has Z transform $X(z) = \frac{1}{(1+z^{-2})^2}$ with ROC $|z| > 1$. Determine the Laplace transform of $2^n x[n]$ including the ROC. The transform has the form $\frac{A}{(1+Bz^{-2})^2}$ and the ROC has the form $|z| > C$. What is $A + B + C$? Choose the closest answer.
A: 6.
B: 7.
C: 10.
D: 8.
E: 9.

Question 3: Suppose $x(s)$ has Laplace transform $X(s)$ with ROC $-2 < \text{Re}\{s\} < 0$. Suppose $y(t) = x(-t) + e^t x(t)$. Determine the ROC for $y(t)$. The answer has the form $A < \text{Re}\{s\} < B$. What is $A + B$? Choose the closest answer.
A: 3.
B: 4.
C: 5.
D: 2.
E: 1.

Question 4: Suppose $X(s) = \frac{1}{s+2} + \frac{2}{s+1} + \frac{3}{s} + \frac{1}{s-1} + \frac{2}{s-2}$ with ROC $-1 < \text{Re}\{s\} < 0$. Determine $x(t)$. The answer has the form $Ae^{-2t}u(Bt) + Ce^{-t}u(Dt) + Eu(Ft) + Ge^{t}u(Ht) + Ie^{2t}u(Jt)$, where B, D, F, H, and J are each ± 1. What is $A + B + C + D + E + F + G + H + I + J$? Choose the closest answer.
A: -4.
B: -5.
C: -1.
D: -3.
E: -2.

Question 5: Suppose $X(z) = \frac{2-3z^{-2}}{1+z^{-1}}$ with ROC $|z| > 1$. It follows that $x[n] = A\delta[n] + B\delta[n-1] + C(-1)^n u[n]$. Determine A. Choose the closest answer.
A: 4.
B: 5.
C: 1.
D: 3.
E: 2.

Question 6: The signal $x(t) = J_0(t)u(t)$ has Laplace transform $X(s) = \frac{1}{\sqrt{1+s^2}}$ with ROC $\text{Re}\{s\} > 0$. (The signal is a Bessel function but you don't need to know anything about Bessel functions to solve this problem.) Suppose $y(t) = 100 \int_{-\infty}^{t} x(\tau - 1) d\tau$. Determine $Y(s)$. What is $Y(2)$? Choose the closest answer. *Hint:* First find the Laplace transform of $x(t-1)$.
A: 2.
B: 3.
C: 4.
D: 1.
E: 5.

Question 7: Suppose $X(s) = \frac{2s+4}{s^2+6s+13}$ with ROC $\text{Re}\{s\} > -3$. Determine $x(t)$. The answer has the form $e^{-At}(B\cos(Ct) + D\sin(Ct))u(t)$ where $C > 0$. What is $A + B + C + D$? Choose the closest answer.
A: 7.
B: 6.
C: 5.
D: 8.
E: 9.

Question 8: Suppose $X(s) = \frac{(s-1)^2}{(s+1)^2(s+2)^2}$ with ROC $\text{Re}\{s\} > -1$. It follows that $x(t) = (A+Bt)e^{-t}u(t) + (C+Dt)e^{-2t}u(t)$. What is C? Choose the closest answer.
A: 12.
B: 16.
C: 8.
D: 20.
E: 4.

Question 9: Suppose $x[n] = (\frac{2}{3})^n \cos(\frac{\pi}{3}n)u[n]$. Determine $X(z)$. The answer has the form $\frac{A+Bz^{-1}}{1+Cz^{-1}+Dz^{-2}}$. Determine $A+B+C+D$. Choose the closest answer. You do not need to determine the ROC.
A: 0.1.
B: 0.3.
C: 0.7.
D: 0.5.
E: 0.9.

Question 10: Suppose $x(t) = te^t u(t) + e^{2t}u(-t) + u(t)$. Which statement is correct?
A: The Laplace transform exists but the Fourier transform does not.
B: The Fourier transform exists but the Laplace transform does not.
C: The Laplace and Fourier transforms exist and $X(j\omega)$ can be found by substituting $s = j\omega$ in $X(s)$.
D: Neither the Laplace transform nor the Fourier transform exists.
E: The Laplace and Fourier transforms exist but $X(j\omega)$ can not be found by substituting $s = j\omega$ in $X(s)$.

Question 11: Suppose the signal $x[n]$ has Z transform $X(z) = \frac{1}{1+2z^{-1}+5z^{-2}}$. Suppose $Y(z) = \frac{2+3z^{-1}}{1+2z^{-1}+5z^{-2}}$. Determine $y[n]$ as a function of $x[n]$. The answer has the form $Ax[n] + Bx[n+C]$. What is $A+B+C$? Choose the closest answer. You do not need to determine the ROC in this problem.
A: 2.
B: 1.
C: 4.
D: 3.
E: 5.

Question 12: Suppose a signal $x(t)$ has Laplace transform $X(s) = \frac{s}{\sqrt{s^2+1}}$. Suppose $y(t)] = tx(t)$. Determine $Y(s)$. The answer has the form $\frac{As+B}{(s^2+1)^C}$. What is $A+B+C$? Choose the closest answer. You do not need to determine the ROC.
A: 0.5.
B: 4.5.
C: 3.5.
D: 1.5.
E: 2.5.

Answers: DAAC ACEB DDCC

Serial Number: **601** Name:

ECE 3300 Fall 2015 (Signals, Systems, and Transforms): Exam VI

Record your name on this test; record your name, student ID, and test serial number on the scantron. Enter the test serial number in *COURSE*; you may leave *SECTION* blank. You must show your work on every problem, showing all steps on your test. Do not use scratch paper or write your work anywhere but on the test. The examination lasts 50 minutes and you may use six sheets of notes (front and back); no old test questions can be on your notes. Calculator use is permitted. There is one correct answer per question.

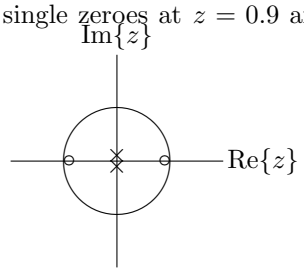
Question 1: Suppose an LTI system has impulse response $h[n] = \delta[n] + (-1)^n u[n]$ and input $x[n] = \delta[n] + (-\frac{1}{2})^n u[n]$. The output has the form $y[n] = A\delta[n] + B(C)^n u[n]$. Determine $A + B + C$. Choose the closest answer.
A: 4.
B: 5.
C: 1.
D: 3.
E: 2.

Question 2: Consider a linear time-invariant system with impulse response $h(t) = \delta(t) - e^{-2t}\cos(t)u(t)$. The input-ouput differential equation for this system can be shown to have the form

$$y''(t) + Ay'(t) + By(t) = Cx''(t) + Dx'(t) + Ex(t)$$

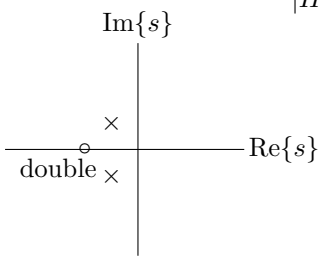
Determine $(A + B) - (C + D + E)$. Choose the closest answer.
A: 2.
B: 1.
C: 0.
D: -2.
E: -1.

Question 3: Consider the pole-zero plot shown. The zeroes are single zeroes at $z = 0.9$ and $z = -0.9$, and the poles are single poles at $z = 0.1j$ and $-0.1j$. This filter is
A: Bandpass.
B: Bandstop.
C: Lowpass.
D: Highpass.
E: Allpass.



Question 4: Consider a linear time-invariant system with impulse response $h[n] = \delta[n-1] + 2^n u[n]$. Determine $H_I(z)$, the Z transform of the INVERSE system of $h[n]$. $H_I(z)$ has the form $A\frac{(1-Bz^{-1})}{(1-Cz^{-1})(1-Dz^{-1})}$. What is $(A + B) - (C + D)$? Choose the closest answer.
A: 5.
B: 1.
C: 4.
D: 3.
E: 2.

Question 5: For the system with pole-zero plot shown, there are single poles at $s = -1 + j$ and $s = -1 - j$ and there is a double zero at $s = -2$. Determine $\frac{|H(j2)|}{|H(j0)|}$. Choose the closest answer. *Hint:* This can be determined from the plot.



A: 0.9.
B: 1.2.
C: 0.8.
D: 1.1.
E: 1.0.

Question 6: Suppose $h(t) = 2e^{-t}u(t) - e^{-At}u(t)$. What should A be so that the system has a single zero at $s = -5$? Choose the closest answer.
A: 1.
B: 5.
C: 3.
D: 4.
E: 2.

Question 7: Suppose a linear time-invariant system with input $x[n]$ and output $y[n]$ is governed by the difference equation $y[n] - 3y[n-1] - 4y[n-2] = x[n] - 4x[n-2]$. Determine $H(z)$. The causal realization of $H(z)$ is $h[n] = A(B)^n u[n] + C(D)^n u[n] + E\delta[n]$. What is $B + D$? Choose the closest answer. *Hint:* It is not necessary to complete the partial-fraction expansion to answer this question.
A: 0.
B: 2.
C: 1.
D: 4.
E: 3.

Question 8: Suppose a pre-sampled signal has maximum frequency 85 kHz and the signal is sampled at rate 200,000 samples per second. Determine the percentage oversampling. Choose the closest answer.
A: 27%.
B: 18%.
C: 15%.
D: 24%.
E: 21%.

Question 9: Consider a linear time-invariant system with input $x(t) = \delta(t) - 3e^{-5t}u(t)$ and output $y(t) = e^{-5t}u(t)$. Determine all possible impulse responses $h(t)$. The answer has the form $Ae^{-Bt}u(t)$, $Ce^{-Dt}u(-t)$, or both. If the answer has the form $Ae^{-Bt}u(t)$, determine $A + B$. If the answer has the form $Ce^{-Dt}u(-t)$, determine $C + D$. If the answer is both, determine $A + B + C + D$. Choose the closest answer.
A: 1.
B: 5.
C: 3.
D: 4.
E: 2.

Question 10: Consider two linear time-invariant systems with impulse responses $h_1(t) = \delta(t) + e^{-t}u(t)$ and $h_2(t) = \delta(t) - 3e^{-4t}u(t)$ and suppose that the two systems are arranged in a causal feedback combination (the system with impulse response $h_2(t)$ is the one "fed back"). Determine $H(s)$ for the composite feedback system. The answer has the form $A\frac{(s+B)(s+C)}{(s+D)(s+E)}$. Determine $(B+C)-(D+E)$. Choose the closest answer.
A: 0.
B: -1.
C: 1.
D: 2.
E: -2.

Question 11: Suppose a system with transfer function $H(z)$ is such that there is a double pole at $z = \frac{1}{2}$ and single zeroes at $z = -1 + j$ and $z = -1 - j$. Suppose $\sum_{n=-\infty}^{\infty} h[n] = 180$. What is $\sum_{n=-\infty}^{\infty}(-1)^n h[n]$? Choose the closest answer. *Hint:* Because $H(z) = \sum_{n=-\infty}^{\infty} h[n]z^{-n}$, it follows that $\sum_{n=-\infty}^{\infty} h[n] = H(1)$ and $\sum_{n=-\infty}^{\infty}(-1)^n h[n] = H(-1)$.
A: 2.
B: 3.
C: 4.
D: 1.
E: 5.

Question 12: Consider a linear time-invariant system given by $H(z) = \frac{(1+2z^{-1})(1-2z^{-1})}{(1+z^{-1})(1-z^{-1})^2(1+\frac{1}{2}z^{-1})}$. Let T denote the total number of realizations of this system. Let C denote the number of these realizations that are causal and S the number that are stable. Determine $T + C + S$.
A: 7.
B: 3.
C: 4.
D: 6.
E: 5.

Answers: CDDA EDDD BBDD

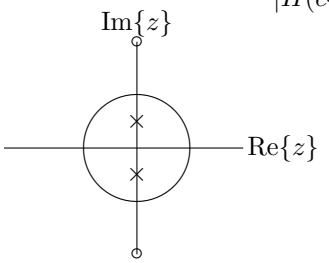
Serial Number: **601** Name:

ECE 3300 Fall 2016 (Signals, Systems, and Transforms): Exam VI

Record your name on this test; record your name, student ID, and test serial number on the scantron. Enter the test serial number in *COURSE*; you may leave *SECTION* blank. You must show your work on every problem, showing all steps on your test. Do not use scratch paper or write your work anywhere but on the test. Circle your answers on the test and bubble in the corresponding answers on your scantron. The examination lasts 60 minutes and you may use six sheets of notes (front and back); no old test questions can be on your notes. Calculator use is permitted. There is one correct answer per question. In problems asking to find coefficients A, B, C, etc., some of these coefficients may equal zero.

Question 1: Consider a linear time-invariant system with impulse response $h[n] = \frac{1}{3}\delta[n] - \frac{2}{3}(2)^n u[-n-1]$. Determine $h_I[n]$, the impulse response of the causal INVERSE system. This impulse response has the form $h_I[n] = A\delta[n] + B(C)^n u[n]$. What is $A + B + C$? Choose the closest answer.
A: 5.
B: 1.
C: 2.
D: 4.
E: 3.

Question 2: For the system with pole-zero plot shown, there are single poles at $z = \frac{j}{2}$ and $z = -\frac{j}{2}$ and there are single zeroes at $z = 2j$ and $z = -2j$. Determine $\frac{|H(e^{j\pi/2})|}{|H(e^{j0})|}$. Choose the closest answer. *Hint:* This can be determined from the plot.
A: 0.6.
B: 0.8.
C: 0.4.
D: 1.0.
E: 0.2.



Question 3: Suppose a causal system with transfer function $H(z)$ is such that there is a double pole at $z = -1$ and single zeroes at $z = 0$ and $z = -\frac{1}{2}$. Assume $H(1) = \frac{1}{2}$. What is $H(-2)$? Choose the closest answer.
A: 3.
B: 1.
C: 5.
D: 4.
E: 2.

Question 4: Suppose an LTI system has impulse response $h[n] = \delta[n] - 2(2)^n u[-n-1]$ and input $x[n] = \delta[n] + (\frac{2}{3})^n u[n]$. The output has the form $y[n] = \delta[n] - A(2)^n u[-n-1]$. Determine A. Choose the closest answer.
A: 5.
B: 1.
C: 4.
D: 3.
E: 2.

Question 5: Consider a linear time-invariant system with impulse response $h[n] = \delta[n] + (-1)^n(n+2)u[n]$. The input-ouput difference equation for this system can be shown to have the form

$$y[n] + Ay[n-1] + By[n-2] = Cx[n] + Dx[n-1] + Ex[n-2]$$

Determine $(C+D) - (A+B+E)$. Choose the closest answer. *Hint:* Careful - this is NOT asking for $A+B+C+D+E$.
A: 0.
B: -2.
C: 1.
D: -1.
E: 2.

Question 6: Consider two linear time-invariant systems with impulse responses $h_1(t) = \delta(t) + 6e^t u(t)$ and $h_2(t) = \delta(t)$ and suppose that the two systems are arranged in a causal feedback combination (the system with impulse response $h_2(t)$ is the one "fed back"). Determine $h(t)$ for the composite feedback system. The answer has the form $A\delta(t) + Be^{-Ct}u(t)$. Determine $A+B+C$. Choose the closest answer.
A: 1.
B: 5.
C: 3.
D: 4.
E: 2.

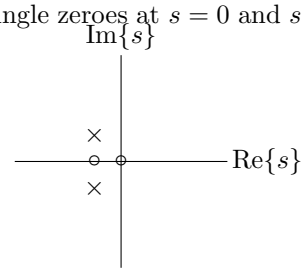
Question 7: Suppose a signal is sampled at 20% oversampling and a sampling rate of 585 ksamples/sec. Determine the maximum frequency of the pre-sampled signal. Choose the closest answer.
A: 500 kHz.
B: 750 kHz.
C: 1250 kHz.
D: 250 kHz.
E: 1000 kHz.

Question 8: Consider a linear time-invariant system given by $H(z) = \frac{1}{1-z^{-1}} + \frac{1}{1+z^{-1}} + \frac{1}{1-\frac{1}{2}z^{-1}} + \frac{1}{1+\frac{1}{2}z^{-1}}$. Let T denote the total number of realizations of this system. Let C denote the number of these realizations that are causal and S the number that are stable. Determine $T+C+S$.
A: 6.
B: 7.
C: 3.
D: 4.
E: 5.

Question 9: Consider a linear time-invariant system with input $x(t)$ and output $y(t)$ such that $X(s) = \frac{s(s+2)}{(s+1)^2}$, $Y(s) = \frac{s}{(s+1)^2}$, and both have ROC $\text{Re}\{s\} < -1$. Determine all possible impulse responses $h(t)$. The answer has the form $Ae^{-Bt}u(t)$ (in which case determine $A+B$), $Ce^{-Dt}u(-t)$ (in which case determine $C+D$), or both (in which case determine $A+B+C+D$). Choose the closest answer.
A: 6.
B: 4.
C: 3.
D: 5.
E: 2.

Question 10: Consider the pole-zero plot shown. The zeroes are single zeroes at $s = 0$ and $s = -1$, and the poles are single poles at $s = -1 + j$ and $s = -1 - j$. This filter is

A: Allpass.
B: Highpass.
C: Bandstop.
D: Bandpass.
E: Lowpass.



Question 11: Suppose $h(t) = e^{-t}\cos(2t)u(t)$. Determine the poles and zeroes. What is the sum of the values of all the poles and zeroes? Choose the closest answer.

A: -5.
B: -2.
C: -1.
D: -3.
E: -4.

Question 12: Suppose a linear time-invariant system with input $x(t)$ and output $y(t)$ is governed by the differential equation $\frac{d^2}{dt^2}y(t) + \frac{d}{dt}y(t) - 2y(t) = \frac{d}{dt}x(t) + x(t)$. Determine $H(s)$. The stable realization of $H(s)$ is $h(t) = Ae^{Bt}u(t) + Ce^{Dt}u(-t)$. What is $B + D$? Choose the closest answer. *Hint:* It is not necessary to complete the partial-fraction expansion to answer this question.

A: -2.
B: 0.
C: 2.
D: -1.
E: 1.

Answers: EDEE CABA DEDC

Serial Number: **601** Name:

ECE 3300 Spring 2016 (Signals, Systems, and Transforms): Exam VI

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Question 1: Consider a linear time-invariant system with impulse response $h(t) = (2t-1)e^{-t}u(t)$. The input-ouput differential equation for this system can be shown to have the form

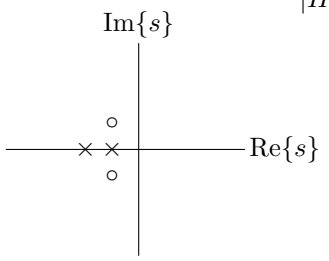
$$y''(t) + Ay'(t) + By(t) = Cx''(t) + Dx'(t) + Ex(t)$$

Determine $A + B + C + D + E$. Choose the closest answer.
A: 1.
B: 4.
C: 2.
D: 5.
E: 3.

Question 2: Suppose a pre-sampled signal has maximum frequency 425 kHz and the signal is sampled at rate 1,000,000 samples per second. Determine the percentage oversampling. Choose the closest answer.
A: 27%.
B: 24%.
C: 15%.
D: 18%.
E: 21%.

Question 3: Suppose a causal system with transfer function $H(s)$ is such that there are single poles at $s = -2$ and $s = -4$ and single zeroes at $s = -1$ and $s = -5$. Assume $H(0) = 1$. What is $H(4)$? Choose the closest answer.
A: 5.5.
B: 3.5.
C: 2.5.
D: 4.5.
E: 1.5.

Question 4: For the system with pole-zero plot shown, there are single poles at $s = -1$ and $s = -2$ and there are single zeroes at $s = -1 + j$ and $s = -1 - j$. Determine $\dfrac{|H(j1)|}{|H(j0)|}$. Choose the closest answer. *Hint:* This can be determined from the plot.



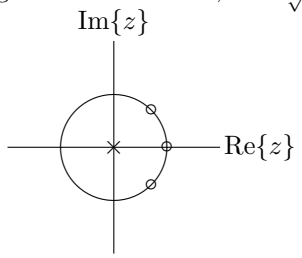
A: 0.4.
B: 1.3.
C: 1.0.
D: 1.6.
E: 0.7.

Question 5: Suppose a linear time-invariant system with input $x[n]$ and output $y[n]$ is governed by the difference equation $y[n] - 4y[n-1] + 4y[n-2] = x[n] - 2x[n-1] + x[n-2]$. Determine $H(z)$. The causal realization of $H(z)$ is $h[n] = (A + Bn)(C)^n u[n] + D\delta[n]$. What is C? Choose the closest answer. *Hint:* It is not necessary to complete the partial-fraction expansion to answer this question.
A: -2.
B: 1.
C: 2.
D: -1.
E: 0.

Question 6: Consider a linear time-invariant system with input $x[n] = \delta[n] - 2(-1)^n u[n]$ and output $y[n] = (-1)^n u[n]$. Determine all possible impulse responses $h[n]$. The answer has the form $Au[n]$, $Bu[-n-1]$, or both. If the answer has the form $Au[n]$, determine A. If the answer has the form $Bu[-n-1]$, determine B. If the answer is both, determine $A + B$. Choose the closest answer.
A: -1.
B: 2.
C: -2.
D: 0.
E: 1.

Question 7: Consider two linear time-invariant systems with impulse responses $h_1[n] = (\frac{1}{2})^n u[n]$ and $h_2[n] = \frac{1}{2}\delta[n]$ and suppose that the two systems are arranged in a causal feedback combination (the system with impulse response $h_2[n]$ is the one "fed back"). Determine $h[n]$ for the composite feedback system. The answer has the form $A(B)^n u[n]$. Determine $A + B$. Choose the closest answer. *Hint:* $\frac{c}{a - bz^{-1}} = \frac{c/a}{1-(b/a)z^{-1}}$.
A: $\frac{5}{3}$.
B: 1.
C: $\frac{1}{3}$.
D: $\frac{2}{3}$.
E: $\frac{4}{3}$.

Question 8: Consider the pole-zero plot shown. The zeroes are single zeroes at $z = 1$, $z = \frac{1}{\sqrt{2}}(1+j)$, and $z = \frac{1}{\sqrt{2}}(1-j)$, and the pole is a triple pole at $z = 0$. This filter is



A: Highpass.
B: Lowpass.
C: Bandpass.
D: Allpass.
E: Bandstop.

Question 9: Suppose an LTI system has impulse response $h(t) = 7e^{-3t}u(t) - \delta(t)$ and input $x(t) = (7 + 14t)e^{4t}u(-t)$. The output has the form $y(t) = Ae^{4t}u(-t) + Be^{-3t}u(t)$. Determine $A + B$. Choose the closest answer.
A: 2.
B: 5.
C: 4.
D: 3.
E: 1.

Question 10: Suppose $h[n] = -(-2)^n u[-n-1] + u[n]$. How many zeroes does $H(z)$ have? Choose the closest answer.
A: 1.
B: 3.
C: 0.
D: 4.
E: 2.

Question 11: Consider a linear time-invariant system given by $H(s) = \frac{1}{s+2} + \frac{1}{(s+2)^2} + \frac{1}{s-2} + \frac{1}{s-4}$. Let T denote the total number of realizations of this system. Let C denote the number of these realizations that are causal and S the number that are stable. Determine $T + C + S$.
A: 3.
B: 5.
C: 7.
D: 6.
E: 4.

Question 12: Consider a linear time-invariant system with impulse response $h(t) = \delta(t) + 2e^{-t}\cos(t)u(t)$. Determine $h_I(t)$, the impulse response of the causal INVERSE system. This impulse response has the form $h_I(t) = A\delta(t) + (Bt + C)e^{-Dt}u(t)$. What is $A + B + C + D$? Choose the closest answer.
A: 1.
B: 4.
C: 3.
D: 5.
E: 2.

Answers: BDAC CBCA ACBE

Serial Number: **601** Name:

ECE 3300 Spring 2017 (Signals, Systems, and Transforms): Exam VI

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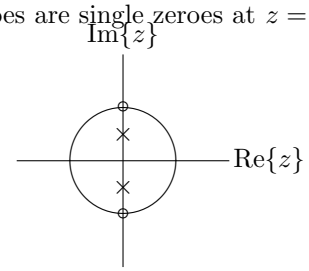
Question 1: Consider the pole-zero plot shown. The zeroes are single zeroes at $z = j$ and $z = -j$, and the poles are single poles at $z = \frac{j}{2}$ and $z = -\frac{j}{2}$. This filter is



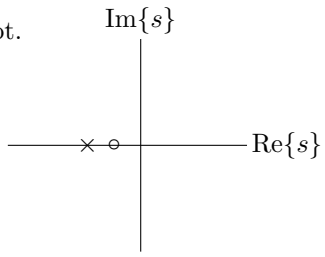
A: Bandpass.
B: Bandstop.
C: Highpass.
D: Allpass.
E: Lowpass.

Question 2: Consider a linear time-invariant system given by $H(s) = \frac{1}{s+1} + \frac{1}{(s+1)^2} + \frac{1}{s-1} + \frac{1}{(s-1)^2} + \frac{1}{s-2} + \frac{1}{(s-2)^2}$. Let T denote the total number of realizations of this system. Let C denote the number of these realizations that are causal and S the number that are stable. Determine $T + C + S$.
A: 3.
B: 4.
C: 7.
D: 6.
E: 5.

Question 3: Consider a linear time-invariant system with impulse response $h(t) = \delta(t) - e^{-t}\sin(t)u(t)$. Determine $h_I(t)$, the impulse response of the causal INVERSE system. This impulse response has the form $h_I(t) = A\delta(t) + (B + Ct)e^{-Dt}u(t)$. What is $A + B + C + D$? Choose the closest answer.
A: 3.
B: 1.
C: 5.
D: 2.
E: 4.

Question 4: Suppose $h(t) = 16e^{-2t}u(t) + 14e^{-t}u(-t)$. Determine the poles and zeroes. What is the sum of the values of all the poles and zeroes? Choose the closest answer.
A: 2.
B: 4.
C: 3.
D: 5.
E: 1.

Question 5: For the system with pole-zero plot shown, there is a single pole at $s = -2$, and there is a single zero at $s = -1$. Determine $\frac{|H(j1)|}{|H(j0)|}$. Choose the closest answer. *Hint:* This can be determined from the plot.



A: 0.5.
B: 0.75.
C: 1.25.
D: 1.5.
E: 1.0.

Question 6: Suppose a signal has maximum frequency 80 kHz. This signal is oversampled and has a sampling rate of 200 ksamples/sec. Determine the percentage oversampling. Choose the closest answer.
A: 10%.
B: 25%.
C: 15%.
D: 30%.
E: 20%.

Question 7: Consider a linear time-invariant system with input $x[n] = (n+1)u[n]$ and output $y[n] = \frac{1}{2}u[n] + \frac{1}{2}(-1)^n u[n]$ Determine the causal impulse response $h[n]$. Determine $h[0]$, $h[1]$, and $h[2]$. What is $h[0] + h[1] + h[2]$? Choose the closest answer.
A: 0.
B: -2.
C: 1.
D: 2.
E: -1.

Question 8: Consider a linear time-invariant system with impulse response $h(t) = 2\delta(t) - e^{-t}u(t) - e^{-2t}u(t)$. The input-ouput differential equation for this system can be shown to have the form

$$y''(t) + Ay'(t) + By(t) = Cx''(t) + Dx'(t) + Ex(t)$$

Determine $A + B + C + D + E$. Choose the closest answer.
A: 12.
B: 13.
C: 14.
D: 10.
E: 11.

Question 9: Suppose a linear time-invariant system with input $x[n]$ and output $y[n]$ is governed by the difference equation $y[n] - y[n-2] = x[n] + 4x[n-1] + 4x[n-2]$. Determine $H(z)$. The causal realization of $H(z)$ is $h[n] = A\delta[n] + B(C)^n u[n] + D(E)^n u[n]$. What is $C + E$? Choose the closest answer. *Hint:* It is not necessary to complete the partial-fraction expansion to answer this question.
A: 0.
B: 1.
C: -2.
D: -1.
E: 2.

Question 10: Suppose an LTI system has impulse response $h(t) = e^{-t}u(t) - e^{t}u(-t)$ and input $x(t) = (-1-t)u(t)$. The output has the form $y(t) = Au(t) + Be^{-t}u(t) + Ce^{t}u(-t)$. Determine $A + B + C$. Choose the closest answer.
A: 3.
B: 5.
C: 4.
D: 1.
E: 2.

Question 11: Suppose a causal system with transfer function $H(z)$ is such that there are poles at $z = \frac{1}{2} + \frac{1}{2}j$ and $z = \frac{1}{2} - \frac{1}{2}j$ and double zeroes at $z = -1$. Assume $H(0) = 1$. What is $H(1)$? Choose the closest answer.
A: 1.
B: 4.
C: 2.
D: 3.
E: 5.

Question 12: Consider two linear time-invariant systems with impulse responses $h_1[n] = 2(\frac{1}{2})^n u[n]$ and $h_2[n] = \frac{1}{2}\delta[n-1]$ and suppose that the two systems are arranged in a causal feedback combination (the system with impulse response $h_2[n]$ is the one "fed back"). Determine $h[n]$ for the composite feedback system. The answer has the form $A\delta[n] + B(C)^n u[n]$. Determine $A + B + C$. Choose the closest answer.
A: 2.5.
B: 3.5.
C: 4.5.
D: 0.5.
E: 1.5.