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.