Serial Number: **101**

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Put your name **also** on the second page.

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. Write your letter answers in the bubbles next to each problem and on the first page. 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.

Serial Number: **101** Name:

ECE 3300 Fall 2017 (Signals, Systems, and Transforms): Exam 2

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

A: 7.
B: 4.
C: 6.
D: 5.
E: 3.

Question 2: Consider the system $y(t) = \frac{4x^2(t-1)}{1+x(t)+2x(t-2)}$. Let $g(t)$ be the step response of this system. The step response can be written in the form $A(u(t) - u(t-1)) + B(u(t-1) - u(t-2)) + Cu(t-2)$. Determine $A + B + C$. Choose the closest answer. *Hint:* Consider the cases $t < 0$, $0 < t < 1$, $1 < t < 2$, and $t > 2$ separately.

A: 5.
B: 4.
C: 3.
D: 7.
E: 6.

Question 3: Suppose $x(t)$ and $h(t)$ have no impulses and further suppose that

$$[x * h](t) = \begin{cases} 2t + 4 & \text{if } A < t \leq B \\ 9 - 3t & \text{if } B < t \leq C \\ 0 & \text{otherwise} \end{cases}$$

Assume $A < B < C$ and use the "checking" properties of convolution to determine A, B, and C. What is $A+B+C$? Choose the closest answer.

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

Question 4: Consider the system with input $x(\cdot)$ and output $y(\cdot)$ such that $y(t) = x(\frac{t}{2} - 1) + u(t - 1)$. Is this system memoryless? Causal?

A: There is insufficient information to determine an answer.
B: Memoryless and causal.
C: Neither memoryless nor causal.
D: Memoryless but not causal.
E: Causal but not memoryless.

Question 5: Suppose $x(t) = f(t)(u(t) - u(t - 2))$ and $h(t) = u(t + 2)$, where $f(t)$ is some function. For $-2 < t < 0$, the convolution of $x(t)$ with $h(t)$ has the form $\int_{At+B}^{Ct+D} f(\tau)d\tau$. What is $A + B + C + D$? Choose the closest answer.

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

Question 6: Let $y[n]$ denote the convolution of $x[n] = 3\delta[n-2] - 2\delta[n-3] + \delta[n-4]$ and $h[n] = \delta[n] - 2\delta[n-1] + 3\delta[n-2]$. Determine the sum of $y[4]$, $y[5]$, and $y[6]$. Choose the closest answer.

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

Question 7: Consider a LTI system with impulse response $h(t)$ and periodic input $\tilde{x}(t)$ with $T_0 = 2$ such that the convolution of the impulse response with the fundamental cycle of the input is $(x * h)(t) = t^2(u(t) - u(t-2)) + (6-t)(u(t-2) - u(t-6))$. If the output is $\tilde{y}(t)$, determine $\tilde{y}(0)$ and $\tilde{y}(1)$. What is the difference $\tilde{y}(0) - \tilde{y}(1)$? Choose the closest answer.

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

Question 8: Consider the system $y[n] = 2x[n] - 3x[n-1]$. This system is

A: Time-invariant because an input of $x[n] = 0$ for all n gives output $y[n] = 0$ for all n.
B: Time-varying because the output due to $x[n] = n - 1$ is a delay by -1 of the output due to $x[n] = n$.
C: Time-varying because the output due to $x[n] = 3$ is a not a delay by 1 of the output due to $x[n] = 2$.
D: Time-invariant because the output due to $x[n] = n - 1$ is a delay by 1 of the output due to $x[n] = n$.
E: 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 $x[\cdot]$.

Question 9: Consider an LTI system with impulse response $h[n] = 3\delta[n] + n(u[n-1] - u[n-100])$. 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 10: Consider the system with input $x(\cdot)$ and output $y(\cdot)$ such that $y(t) = e^{-t}x(t) + x(0)$. This system is

A: Unstable because the input $x(t) = e^{2t}$ for all t gives an unbounded output.
B: Stable because $|x(t)| \leq A$ for all t implies that $|y(t)| \leq B$ for all t for $B = 2A$.
C: Unstable because the input $x(t) = 1$ for all t gives an unbounded output.
D: Unstable because the input $x(t) = e^{t}$ for all t gives an unbounded output.
E: Stable because the input $x(t) = e^{-t}$ for all t gives a bounded output.

Question 11: Consider the system defined by $y[n] = x[n] - 2x[n-1] + 1$ where $x[\cdot]$ is the input and $y[\cdot]$ is the output. This system is

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

Question 12: Consider the system with input $x(\cdot)$ and output $y(\cdot)$ such that $y(t) = t^3 x(t-1) - x(0)$. This system is

A: Nonlinear because, for the input $x(t) = 1$ for all t, doubling the input does not double the output.
B: Nonlinear because $y(2t) \neq 2y(t)$; that is, doubling t does not double $y(t)$.
C: Nonlinear because, for the input $x(t) = 1$ for all t, the output is $t^3 + 1$ which is nonlinear.
D: Linear because, for all inputs $x_1(t)$ and $x_2(t)$ and all constants a_1 and a_2, the output due to $a_1 x_1(t) + a_2 x_2(t)$ is $a_1 y_1(t) + a_2 y_2(t)$, where $y_1(t)$ is the output due to $x_1(t)$ and $y_2(t)$ is the output due to $x_2(t)$.
E: Linear because an input of $x(t) = (t+1)^{-3}$ gives output $y(t) = 0$ which is linear.