Serial Number: **201**

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1	2	3	4	5	6	7	8	9	10	11	12

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 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.

Serial Number: **201** Name:

ECE 3300 Fall 2017 (Signals, Systems, and Transforms): Exam 4

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Question 1: Consider a linear time-invariant system such that $h(t) = \delta(t) - e^{-3t}u(t)$. If the input $\tilde{x}(t)$ is periodic with period $T_0 = 6\pi$ and Fourier series coefficients x_k, determine the output Fourier series coefficient y_3. The answer has the form $y_3 = \frac{A+j}{B+j}x_3$. What is $A + B$? Choose the closest answer. *Hint:* First find $H(j\omega)$ and write in the form $\frac{a+j\omega}{b+j\omega}$.

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

Question 2: Consider a linear time-invariant system with impulse response $h(t) = (t+3)e^{-t}u(t)$. Determine the magnitude response. What is the value of the magnitude response at $\omega = 1$? Choose the closest answer.

A: 3.5.
B: 2.5.
C: 4.5.
D: 1.5.
E: 0.5.

Question 3: Consider a linear time-invariant system with impulse response $h(t) = \delta(t) - \frac{1}{\pi t}\sin(2t)$ and input $x(t) = \frac{1}{\pi t}(\sin(t) - \sin(3t))$. 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 $\text{rect}(\frac{\omega}{2a})$. Draw pictures.

A: 9.
B: 7.
C: 6.
D: 5.
E: 8.

Question 4: Consider the low-pass system with frequency response $H(j\omega) = \frac{16}{(\omega^2+16)^2}$. 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 at $\omega = 0$.

A: 6.
B: 5.
C: 2.
D: 3.
E: 4.

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

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

Question 6: Suppose a Bode plot of $|H(j\omega)|$ is a straight line of slope 60 dB/decade between $\omega = 500$ and $\omega = 4000$ such that $|H(j1000)| = -12$ dB. What is $|H(j2500)|$? Choose the closest answer.

A: 30 dB.
B: 24 dB.
C: 12 dB.
D: 6 dB.
E: 18 dB.

Question 7: Consider a linear time-invariant system with impulse response $h(t) = \delta(t) + 3e^{-t}u(t)$. Determine the phase response $\angle H(j\omega)$. The answer has the form $\tan^{-1}(\frac{\omega}{A}) - \tan^{-1}(\frac{\omega}{B})$, where $A > 0$ and $B > 0$. What is $A + B$? Choose the closest answer.

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

Question 8: Suppose $H(j\omega) = \dfrac{10^{-1}(10 + j\omega)(40 + j\omega)(20 + j\omega)^3}{(j\omega)^2(80 + j\omega)^2}$. Determine the value of the Bode straight-line approximation to $|H(j\omega)|$ at $\omega = 20$. Choose the closest answer.

A: -6 dB.
B: -3 dB.
C: -9 dB.
D: -12 dB.
E: -15 dB.

Question 9: Suppose $H(j\omega) = \dfrac{(j\omega)^3(80 + j\omega)^2(300 + j\omega)(600 + j\omega)^2}{(10 + j\omega)(20 + j\omega)^2(160 + j\omega)}$. Determine the slope of the Bode plot in the region from $\omega = 300$ to $\omega = 600$.

A: 40 dB/decade.
B: -20 dB/decade.
C: 0 dB/decade.
D: 20 dB/decade.
E: -40 dB/decade.

Question 10: Consider a linear time-invariant system with $h[n] = (n + 1)(\frac{1}{2})^n u[n]$. Determine group delay $D(\omega)$. What is $D(0)$? Choose the closest answer.

A: 2.
B: 0.5.
C: 1.
D: 2.5.
E: 1.5.

Question 11: Consider the filter with $H(j\omega) = \frac{A(50+j\omega)}{(500+j\omega)(5000+j\omega)}$. Determine the Bode plot (straight-line approximation). Based on this plot, determine the largest value of A such that the system is passive.

A: 500.
B: 50000.
C: 50.
D: 5000.
E: 5.

Question 12: Consider a linear time-invariant system with impulse response $h(t) = e^{-t}u(t)$ and output $y(t) = (2t + 1)e^{-t}u(t)$. Use Fourier techniques to determine the input $x(t)$. The answer has the form $x(t) = A\delta(t) + Be^{-Ct}u(t)$. What is $A + B + C$? Choose the closest answer.

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