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.

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.