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 $\text{rect}(\frac{\omega}{2a})$.
A: 7.
B: 9.
C: 8.
D: 6.
E: 5.