

Serial Number: **101**

Name:

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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 three 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**

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ECE 3300 FALL 2017 (SIGNALS, SYSTEMS, AND TRANSFORMS): EXAM 3

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- ☐ **Question 1:** Determine the Fourier transform of  $(\frac{1}{2})^n u[n-2]$ . The answer has the form  $\frac{e^{-Aj\omega}}{B+Ce^{-j\omega}}$ . What is  $A+B+C$ ? Choose the closest answer. *Hint:* First consider  $(\frac{1}{2})^{n-2} u[n-2]$ . Then consider multiplying this by  $(\frac{1}{2})^2$ .
- A: 4.  
B: 3.  
C: 1.  
D: 5.  
E: 2.

- ☐ **Question 2:** Given that  $a^{|n|}$  has Fourier transform  $\frac{1-a^2}{1+a^2-2a\cos\omega}$  (provided  $|a| < 1$ ), determine the Fourier transform of  $\sum_{m=-\infty}^n (\frac{2}{3})^{|m|}$ . The answer can be written in the form  $\frac{A}{(1-e^{-j\omega})(13-12\cos\omega)} + B\pi\tilde{\delta}_{2\pi}(\omega)$  What is  $A+B$ ? Choose the closest answer.
- A: 7.  
B: 6.  
C: 10.  
D: 8.  
E: 9.

☐ **Question 3:** Suppose that  $x(t)$  has Fourier transform  $X(j\omega)$ . Determine the inverse Fourier transform of  $4X(j\omega) \cos(2\omega)$ . The answer has the form  $Ax(t+B) + Ax(t-B)$ . What is  $A+B$ ? Choose the closest answer. *Hint:*  $\cos \phi = \frac{1}{2}e^{j\phi} + \frac{1}{2}e^{-j\phi}$ .

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

☐ **Question 4:** Suppose  $X(j\omega) = \sqrt{2\pi}$  if  $2 < |\omega| < 5$  and 0 otherwise. Determine the energy in the frequency band  $(3, 8)$ . Choose the closest answer.

A: 4.  
 B: 2.  
 C: 8.  
 D: 10.  
 E: 6.

☐ **Question 5:** Suppose  $\tilde{x}(t)$  has Fourier transform  $2\pi\delta(\omega + \frac{3\pi}{2}) + 4\pi\delta(\omega + \pi) + 5\pi\delta(\omega + \frac{\pi}{2}) + 3\pi\delta(\omega) + 5\pi\delta(\omega - \frac{\pi}{2}) + 4\pi\delta(\omega - \pi) + 2\pi\delta(\omega - \frac{3\pi}{2})$ . Determine  $T_0$  and the Fourier series coefficient  $x_3$ . What is  $T_0 + x_3$ ? Choose the closest answer.

A: 13.  
 B: 7.  
 C: 9.  
 D: 11.  
 E: 5.

☐ **Question 6:** Determine the inverse Fourier transform  $x[n]$  if  $X(e^{j\omega}) = 2e^{-j\omega} + \frac{3}{1-\frac{2}{3}e^{-j\omega}}$ . What is  $x[1]$ ? Choose the closest answer.

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

☐ **Question 7:** Suppose  $x(t) = e^{-t} \sin(t)u(t)$ . Using the fact that  $\int_0^\infty e^{at} \sin(bt) dt = \frac{b}{a^2 + b^2}$  if  $b$  is real and the real part of  $a$  is negative, use the definition of the Fourier transform to determine  $X(j\omega)$ . The answer has the form  $\frac{A+Bj\omega}{C+Dj\omega-\omega^2}$ . What is  $A + B + C + D$ ? Choose the closest answer.

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

☐ **Question 8:** Suppose  $\tilde{x}[n]$  has period  $N_0 = 5$  and Fourier series coefficients  $x_{-2} = 6 + 8j$ ,  $x_2 = 6 - 8j$ ,  $x_{-1} = 10$ ,  $x_1 = 10$ , and  $x_0 = 20$ . (All other coefficients are zero.) Determine the percentage of power in the second harmonic. Choose the closest answer.

A: 50%.  
 B: 12.5%.  
 C: 62.5%.  
 D: 37.5%.  
 E: 25%.

☐ **Question 9:** Suppose  $\tilde{x}(t)$  has fundamental period  $T_0 = 4\pi$  and fundamental cycle  $x(t) = \pi \cos(t) \text{rect}(\frac{t}{2\pi})$ . Determine the Fourier series coefficient  $x_1$ . *Hint:* You may use without proof the fact that the Fourier transform of the fundamental cycle is  $X(j\omega) = \frac{2\omega\pi \sin(\pi\omega)}{1-\omega^2}$ .

A:  $\frac{1}{4}$ .  
 B:  $\frac{2}{3}$ .  
 C:  $\frac{3}{4}$ .  
 D:  $\frac{1}{2}$ .  
 E:  $\frac{1}{3}$ .

☐ **Question 10:** Given that  $x(t)$  has Fourier transform  $\frac{1}{(4+\omega^2)^2}$ , determine the Fourier transform of  $tx(t)$ . The answer has the form  $\frac{A-Bj\omega}{(4+\omega^2)^C}$ . What is  $A + B + C$ ? Choose the closest answer.

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

☐ **Question 11:** Suppose that, for  $-2\pi \leq \omega < 2\pi$ ,  $X(j\omega) = j\text{sgn}(\omega)\cos(\omega)$ ;  $X(j\omega) = 0$  otherwise. At which pair of the following frequencies is the phase equal to  $\frac{\pi}{2}$ ?

A:  $\frac{3\pi}{4}$  and  $-\frac{3\pi}{4}$ .

B:  $\frac{\pi}{4}$  and  $-\frac{\pi}{4}$ .

C:  $\frac{\pi}{4}$  and  $-\frac{3\pi}{4}$ .

D:  $-\frac{\pi}{4}$  and  $-\frac{3\pi}{4}$ .

E:  $\frac{3\pi}{4}$  and  $-\frac{\pi}{4}$ .

☐ **Question 12:** Suppose  $x(t)$  has Fourier transform  $X(j\omega) = \frac{(1+j\omega)e^{-2j\omega}}{(2+j\omega)^2}$ . Determine an expression for the magnitude of the Fourier transform of  $x(t)$ . The answer has the form  $\frac{\sqrt{A+B\omega^2}e^{C\omega}}{D+\omega^2}$ . What is  $A + B + C + D$ ? Choose the closest answer.

A: 10.

B: 9.

C: 6.

D: 8.

E: 7.

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