Solution of EECS 315 Test 4 F13

1. Find the numerical fundamental periods of these sums of discrete-time sinusoids. If the sum is not periodic just write "infinity" or ∞ .

(a) $x[n] = 13\cos(2\pi n/12) + 11\sin(2\pi n/18)$

LCM of 12 and 18 is 36 and that is the fundamental period.

(b) $x[n] = -9\sin(3\pi n/15) + 4\cos(5\pi n/20)$

$x[n] = -9\sin(2\pi n/10) + 4\cos(2\pi n/8)$

LCM of 10 and 8 is 40 and that is the fundamental period.

(c) $x[n] = 22\sin(15\pi n/25) + 8\cos(25\pi n/40)$

$x[n] = 22\sin(2\pi n(15/50)) + 8\cos(2\pi n(25/80))$

$x[n] = 22\sin(2\pi n(3/10)) + 8\cos(2\pi n(5/16))$

LCM of 10 and 16 is 80 and that is the fundamental period.

(d) $x[n] = 9\sin(12n/30) + 8\cos(20n/45)$

$x[n] = 9\sin(2\pi n(1/5\pi)) + 8\cos(2\pi n(2/9\pi))$

Not periodic.

2. A periodic discrete-time signal $\mathrm{x}[n]$ is described over exactly one fundamental period by $\mathrm{x}[n] = 5 - \mathrm{ramp}[n] \quad , \; 3 \le n < 7$.
(Be sure you carefully observe the inequality notation.)

(a) What is the numerical value of $\mathrm{x}[10]$?

Since the period is 4, $\mathrm{x}[10] = \mathrm{x}[10 - 1 \times 4] = \mathrm{x}[6] = 5 - \mathrm{ramp}[6] = -1$.

(b) What is the numerical value of $\mathrm{x}[-5]$?

Since the period is 4, $\mathrm{x}[-5] = \mathrm{x}[-5 + 2 \times 4] = \mathrm{x}[3] = 5 - \mathrm{ramp}[3] = 2$.

(c) Find the numerical average signal power of $\mathrm{x}[n]$.

$$P_{\mathrm{x}} = \frac{1}{N} \sum_{n=\langle N \rangle} \left|\mathrm{x}[n]\right|^2 = \frac{1}{4} \sum_{n=3}^{6} \left|5 - \mathrm{ramp}[n]\right|^2 = \frac{2^2 + 1^2 + 0^2 + (-1)^2}{4} = 1.5$$

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1. Find the numerical fundamental periods of these sums of discrete-time sinusoids. If the sum is not periodic just write "infinity" or ∞ .

(a) $x[n] = 13\cos(2\pi n/15) + 11\sin(2\pi n/20)$

LCM of 15 and 20 is 60 and that is the fundamental period.

(b) $x[n] = -9\sin(3\pi n/15) + 4\cos(5\pi n/35)$

$$x[n] = -9\sin(2\pi n/10) + 4\cos(2\pi n/14)$$

LCM of 10 and 14 is 70 and that is the fundamental period.

(c) $x[n] = 9\sin(12n/30) + 8\cos(20n/45)$

$$x[n] = 9\sin(2\pi n(1/5\pi)) + 8\cos(2\pi n(2/9\pi))$$

Not periodic.

(d) $x[n] = 22\sin(8\pi n/40) + 8\cos(12\pi n/75)$

$$x[n] = 22\sin(2\pi n(1/10)) + 8\cos(2\pi n(4/50))$$

LCM of 10 and 50 is 50 and that is the fundamental period.

2. A periodic discrete-time signal $\mathrm{x}[n]$ is described over exactly one fundamental period by $\mathrm{x}[n] = 5 - \mathrm{ramp}[n] \;\; , \; 3 \le n < 8$.
(Be sure you carefully observe the inequality notation.)

(a) What is the numerical value of $\mathrm{x}[12]$?

Since the period is 5, $\mathrm{x}[10] = \mathrm{x}[12 - 1 \times 5] = \mathrm{x}[7] = 5 - \mathrm{ramp}[7] = -2$.

(b) What is the numerical value of $\mathrm{x}[-7]$?

Since the period is 5, $\mathrm{x}[-7] = \mathrm{x}[-7 + 2 \times 5] = \mathrm{x}[3] = 5 - \mathrm{ramp}[3] = 2$.

(c) Find the numerical average signal power of $\mathrm{x}[n]$.

$$P_{\mathrm{x}} = \frac{1}{N} \sum_{n=\langle N \rangle} \left|\mathrm{x}[n]\right|^2 = \frac{1}{5} \sum_{n=3}^{7} \left|5 - \mathrm{ramp}[n]\right|^2 = \frac{2^2 + 1^2 + 0^2 + (-1)^2 + 2^2}{5} = 2$$

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1. Find the numerical fundamental periods of these sums of discrete-time sinusoids. If the sum is not periodic just write "infinity" or ∞ .

(a) $\mathrm{x}[n]=13\cos(2\pi n/6)+11\sin(2\pi n/9)$

LCM of 6 and 9 is 18 and that is the fundamental period.

(b) $\mathrm{x}[n]=9\sin(12n/30)+8\cos(20n/45)$

$$\mathrm{x}[n]=9\sin(2\pi n(1/5\pi))+8\cos(2\pi n(2/9\pi))$$

Not periodic.

(c) $\mathrm{x}[n]=-9\sin(3\pi n/30)+4\cos(5\pi n/40)$

$$\mathrm{x}[n]=-9\sin(2\pi n/20)+4\cos(2\pi n/16)$$

LCM of 20 and 16 is 80 and that is the fundamental period.

(d) $\mathrm{x}[n]=22\sin(15\pi n/50)+8\cos(25\pi n/80)$

$$\mathrm{x}[n]=22\sin(2\pi n(15/100))+8\cos(2\pi n(25/160))$$

$$\mathrm{x}[n]=22\sin(2\pi n(3/20))+8\cos(2\pi n(5/32))$$

LCM of 20 and 32 is 160 and that is the fundamental period.

2. A periodic discrete-time signal $\mathrm{x}[n]$ is described over exactly one fundamental period by $\mathrm{x}[n] = \mathrm{ramp}[n] - 2 \ , \ 1 \le n < 7$.
(Be sure you carefully observe the inequality notation.)

(a) What is the numerical value of $\mathrm{x}[9]$?

Since the period is 6, $\mathrm{x}[9] = \mathrm{x}[9 - 1 \times 6] = \mathrm{x}[3] = \mathrm{ramp}[3] - 2 = 1$.

(b) What is the numerical value of $\mathrm{x}[-5]$?

Since the period is 6, $\mathrm{x}[-5] = \mathrm{x}[-5 + 1 \times 6] = \mathrm{x}[1] = \mathrm{ramp}[1] - 2 = -1$.

(c) Find the numerical average signal power of $\mathrm{x}[n]$.

$$P_{\mathrm{x}} = \frac{1}{N} \sum_{n=\langle N \rangle} \left|\mathrm{x}[n]\right|^2 = \frac{1}{6} \sum_{n=1}^{6} \left|\mathrm{ramp}[n] - 2\right|^2 = \frac{(-1)^2 + 0^2 + 1^2 + 2^2 + 3^2 + 4^2}{6} = 5.1667$$