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0113620 – Sayısal İşaret İşleme

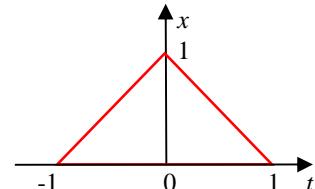
- S1. (a) "Sayısal İşaret İşleme" nedir? (5)
 (b) "Sayısal İşaret İşleme"nin "Analog İşaret İşleme"ye göre üstünlükleri nelerdir? (5)

- S2. (a) Örnekleme teoremi nedir? (5)
 (b) Kaç tür örnekleme vardır? (5)

- S3. $\cos 6A$ ifadesini $\cos 7A$, $\cos 5A$ ve $\cos A$ cinsinden bulunuz. (10)

- S4. Yandaki çizimde x fonksiyonu grafik olarak verildiğine göre;

- (a) $x(t)$ fonksiyonunun t ye bağlı ifadesini yazınız. (5)
 (b) $y(t) = x(t+1)$ olduğuna göre $y(t)$ ifadesini bulunuz. (5)
 (c) $y(t)$ fonksiyonunu çiziniz. (5)

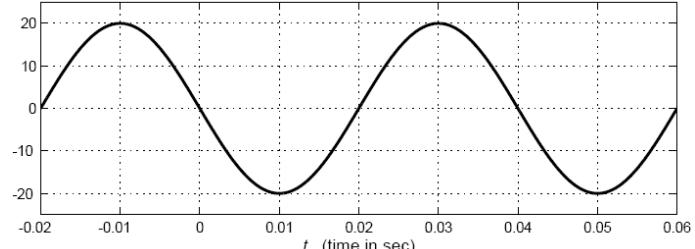


- S5. $x(t) = \Re\{(1+j)e^{j\pi t}\}$ olarak verilen sinusoidal işaretin ait genlik (A), frekans (f) ve faz (ϕ) değerlerini bulunuz. (10)
 $x(t) = A\cos(\omega t + \phi)$

- S6. Yandaki sinusoidal işaret aşağıdaki gibi ifade edilebilir:

$$x(t) = A\cos(\omega_0(t-t_m)) = A\cos(\omega_0 t + \phi) = A\cos(2\pi f_0 t + \phi)$$

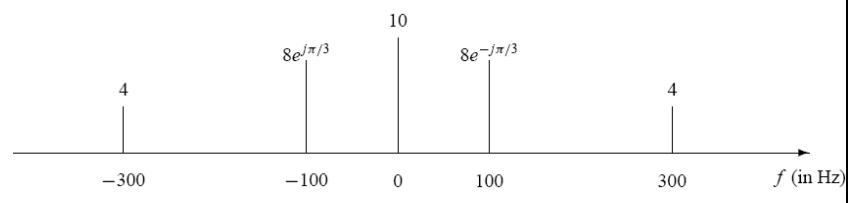
Buna göre A , f_0 , t_m ve ϕ değerlerini belirleyiniz. (10)



- S7. $x(t) = 5 + 2\cos(40\pi t)$ olarak verilen sinusoidal işaretin ait frekans spektrumunu çiziniz. (10)

- S8. Yanda frekans spektrumu verilen $x(t)$ işaretine ait

- (a) denklemi yazınız. (5)
 (b) temel frekansı (fundamental frequency) bulunuz. (5)
 (c) $x(t)$ işaretin $f_s = 300 = 1/T$ örnek/saniye lik bir örnekleme frekansı ile örneklenmesi gereken örneklenmiş ayrık işaret $x[n] = x(nT)$ ifadesini bulup normalize edilmiş spektrumunu çiziniz. (10)



- S9. $5\cos(8.4\pi n + 0.2\pi)$ olarak verilen ayrık sinusoidal işaretin $5\cos(0.4\pi n + 0.2\pi)$ ayrık sinusoidal işaretin katlanması (aliased) hali olduğunu gösteriniz. (10)

$$\cos(a \pm b) = \cos a \cos b \mp \sin a \sin b$$

$$\sin(a \pm b) = \sin a \cos b \pm \cos a \sin b$$

$$e^{j\omega t} = \cos(\omega t) + j \sin(\omega t)$$

$$e^{-j\omega t} = \cos(\omega t) - j \sin(\omega t)$$

CEVAPLAR

C1. (a)

A simple definition of DSP could be “changing or analyzing information which is measured as discrete sequences of numbers”.

(b)

Versatility:

Digital systems can be reprogrammed for other applications

Digital systems can be ported to different hardware

Repeatability:

Digital systems can be easily duplicated

Digital systems do not depend on strict component tolerances

Digital system responses do not drift with temperature

Simplicity:

Some things can be done more easily digitally than with analogue systems

C2. (a)

A continuous time signal $x(t)$ with a maximum frequency content of f_{max} can be reconstructed exactly from its samples $x[n]=x(nT_s)$, if samples are taken at a rate $f_s=1/T_s$ that is greater than $2f_{max}$.

(b)

Over/exact/under sampling

Regular/irregular sampling

Linear/Logarithmic sampling

C3.

$$\cos 5A = \cos(6A - A) = \cos 6A \cos A - \sin 6A \sin A$$

$$\cos 7A = \cos(6A + A) = \cos 6A \cos A + \sin 6A \sin A$$

$$\cos 5A + \cos 7A = \cos(6A - A) + \cos(6A + A) = \cos 6A \cos A - \sin 6A \sin A + \cos 6A \cos A + \sin 6A \sin A$$

$$\cos 5A + \cos 7A = 2 \cos 6A \cos A$$

$$\cos 6A = \frac{\cos 5A + \cos 7A}{2 \cos A}$$

C4.

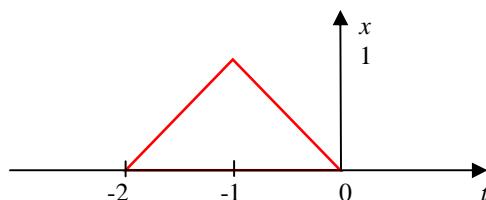
(a)

$$x(t) = \begin{cases} 0 & -\infty < t < -1 \\ t+1 & -1 < t < 0 \\ 1-t & 0 < t < 1 \\ 0 & 1 < t < \infty \end{cases}$$

(b)

$$y(t) = x(t+1) = \begin{cases} 0 & -\infty < t < -2 \\ t+2 & -2 < t < -1 \\ -t & -1 < t < 0 \\ 0 & 0 < t < \infty \end{cases}$$

(c)



C5.

$$x(t) = \Re\{(1+j)e^{j\pi}\} = \Re\{\sqrt{(1+1)}e^{jg^{-1}1}e^{j\pi}\} = \Re\{\sqrt{2}e^{j\frac{\pi}{4}}e^{j\pi}\} = \Re\{\sqrt{2}e^{j(\pi+\frac{\pi}{4})}\}$$

$$x(t) = \Re\left\{\sqrt{2} \cos(\pi t + \frac{\pi}{4}) + j\sqrt{2} \sin(\pi t + \frac{\pi}{4})\right\} = \sqrt{2} \cos(\pi t + \frac{\pi}{4})$$

$$A = \sqrt{2} \quad \omega = 2\pi f = \pi \rightarrow f = \frac{1}{2} = 0.5 \text{ Hz} \quad \phi = \frac{\pi}{4}$$

C6.

$$A = 20 \quad T = 0.04 \text{ sn} \quad f = \frac{1}{T} = \frac{1}{0.04} = 25 \text{ Hz} \quad t_m = -0.01 \text{ sn}$$

$$\phi = -\omega_0 t_m = -2\pi f_0 t_m = -2\pi 25(-0.01) = 0.5\pi = \frac{\pi}{2}$$

C7.

$$x(t) = 5 + 2\cos(40\pi t) = 5e^{j0} + 2\left(\frac{e^{j40\pi t} + e^{-j40\pi t}}{2}\right) = 5e^{j0} + e^{j40\pi t} + e^{-j40\pi t}$$

C8.

(a)

$$x(t) = 10 + 4e^{j600\pi t} + 8e^{j\frac{\pi}{3}}e^{-j200\pi t} + 4e^{-j600\pi t} + 8e^{-j\frac{\pi}{3}}e^{j200\pi t}$$

$$x(t) = 10 + 8\left(\frac{e^{j600\pi t} + e^{-j600\pi t}}{2}\right) + 16\left(\frac{e^{-j\frac{\pi}{3}}e^{j200\pi t} + e^{j\frac{\pi}{3}}e^{-j200\pi t}}{2}\right)$$

$$x(t) = 10 + 8\cos(600\pi t) + 16\cos(200\pi t - \frac{\pi}{3})$$

(b)

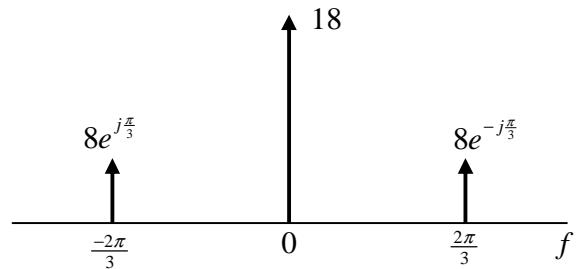
$$fs = 300 \text{ Hz} \quad x[n] = x(nT_s) = x\left(\frac{n}{f_s}\right) = x\left(\frac{n}{300}\right)$$

$$x(t) = 10 + 8\cos(600\pi \frac{n}{300}) + 16\cos(200\pi \frac{n}{300} - \frac{\pi}{3})$$

$$x(t) = 10 + 8\cos(2\pi n) + 16\cos\left(\frac{2\pi}{3}n - \frac{\pi}{3}\right)$$

$$8\cos(2\pi n) = 8$$

$$x(t) = 18 + 16\cos\left(\frac{2\pi}{3}n - \frac{\pi}{3}\right)$$



C9.

$$x(t) = \cos(8.4\pi t + 0.2\pi) = \cos(8\pi t + (0.4\pi t + 0.2\pi))$$

$$x(t) = \cos(8\pi t)\cos(0.4\pi t + 0.2\pi) - \sin(8\pi t)\sin(0.4\pi t + 0.2\pi)$$

$$\cos(8\pi t) = 1 \quad \sin(8\pi t) = 0$$

$$x(t) = \cos(8.4\pi t + 0.2\pi) = \cos(0.4\pi t + 0.2\pi)$$