Imperial College London

MODULE 2 CLASS

Aidan Hogg - 17 October 2019
ELEC96010 (EE3-07): Digital Signal Processing
Department of Electrical and Electronic Engineering

Method:

- o .đĊÔÞĝīİÇă ğİÞĤīñđĊ ĝđĤÞÚ ŕ ĤīİÚÞĊīĤ īîñĊĀ ğİñÞīăł đĊ īîÞñĠ đļĊ ÇĊÚ ĠÞĝđĠī ñĊñīñÇă ÇĊĤļÞĠĤ đĊ `ÞĊīñĉ ÞīÞĠ (3 mins)
- π zīİÚÞĊīĤ ÚñĤÔİĤĤ īîÞñĠ ÇĊĤļÞĠĤ ñĊ Ĥĉ Çăă éĠđİĝĤ (2 mins)
- ρ 8ŁĝăÇĊÇīñđĊдÚñĤÔİĤĤñđĊ đè ÔđĠĠÞÔī ÇĊĤļÞĠ (3 mins)

! ĤñĊÞ ļ ÇĻÞ đè èĠÞğ İ ÞĊÔł
: ñĤ ĤÇ ĉ ĝăÞÚ φ īñ ĉ ÞĤ Çī Ç
ĤÇ ĉ ĝăñĊé èĠÞğ İ ÞĊÔł đè :ɟ

If the plot shows the magnitude response of the 8 samples what where the values of : and :ɟ?

! : ; 0...HŇ :ɟ ; /4...HŇ

- : ; /...HŇ :ɟ ; 4...HŇ

. : ; 0...HŇ :ɟ ; 6...HŇ

! ĤñĊÞ ļ ÇĻÞ đè èĠÞğ İ ÞĊÔł
: ñĤ ĤÇ ĉ ĝăÞÚ φ īñ ĉ ÞĤ Çī Ç
ĤÇ ĉ ĝăñĊé èĠÞğ İ ÞĊÔł đè :ɟ

If the plot shows the magnitude response of the 8 samples what where the values of : and :ɟ?

!⃞ : ; 0. . .HŇ :ɟ ; /4. . .HŇ

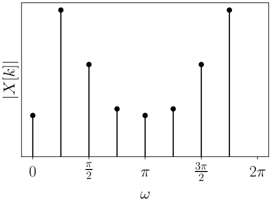
-⃞ : ; / . . .HŇ :ɟ ; 4. . .HŇ

.⃞ : ; 0. . .HŇ :ɟ ; 6. . .HŇ

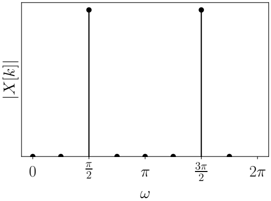
EXPLANATION

!𝕀 : ; 0...HŇ :ɇ ; /4...HŇ

-𝕀 : ; /...HŇ :ɇ ; 4...HŇ



.𝕀 : ; 0...HŇ :ɇ ; 6...HŇ



GO TO WWW.MENTI.COM AND USE THE CODE 76 76 36

What is the effect on the frequency spectrum if a continuous signal E&B' is sampled?

! ¡ î Þ Ĥĝ ÞÔīĠİ ĉ ÓÞÔđ ĉ ÞĤ ĝÞĠñđÚñÔ

- ¡ î Þ Ĥĝ ÞÔīĠİ ĉ ÓÞÔđ ĉ ÞĤ ĠÞÇă

. ¡ î Þ Ĥĝ ÞÔīĠİ ĉ ÓÞÔđ ĉ ÞĤ ĝÞĠñđÚñÔ ÇĊÚ Ĥł ĉ ĉ ÞīĠñÔ

What is the effect on the frequency spectrum if a continuous signal E&B' is sampled?

! The spectrum becomes periodic

- ¡ î Þ Ĥĝ ÞÔīĠ İ ĉ ÓÞÔđ ĉ ÞĤ ĠÞÇă

. ¡ î Þ Ĥĝ ÞÔīĠ İ ĉ ÓÞÔđ ĉ ÞĤ ĝ ÞĠňđÚňÔ ÇĊÚ Ĥł ĉ ĉ ÞīĠňÔ

One Domain	Other Domain
4ñĤÔĠÞīÞ	sÞĠñđÚñÔ
zł ĉ ĉ ÞīĠñÔ	zł ĉ ĉ ÞīĠñÔ
!ĊīñĤł ĉ ĉ ÞīĠñÔ	!ĊīñĤł ĉ ĉ ÞīĠñÔ
vÞÇă	.đĊýİéÇīÞ zł ĉ ĉ ÞīĠñÔ
Ķĉ ÇéñĊÇĠł	.đĊýİéÇīÞ !ĊīñĤł ĉ ĉ ÞīĠñÔ
vÞÇă Ј zł ĉ ĉ ÞīĠñÔ	vÞÇă Ј zł ĉ ĉ ÞīĠñÔ
vÞÇă Ј !ĊīñĤł ĉ ĉ ÞīĠñÔ	Ķĉ ÇéñĊÇĠł Ј !ĊīñĤł ĉ ĉ ÞīĠñÔ

Which ᴇΫ”[will have a purely real םΫת[?

!𝕀 ᴇΫ”[; y.* /* /* .* .* .* L/* L/{

-𝕀 ᴇΫ”[; y/* /* .* /* /* .* /* /{

.𝕀 ᴇΫ”[; y/* /* /* .* /* .* /* /{

ANSWER

Which EΥ”[will have a purely real םΥת[?

!𝕀 EΥ”[; y.* /* /* .* .* .* L/* L/{

-𝕀 EΥ”[; y/* /* .* /* /* .* /* /{

.𝕀 EΥ”[; y/* /* /* .* /* .* /* /{

Which EΥ”[will have a purely real ◻Υת[?

!𝕀 EΥ”[; y.* /* /* .* .* .* L/* L/{

c◻Υת[ļñăă ÓÞ ĝİĠÞăł ñĉ ÇéñĊÇĠłт

-𝕀 EΥ”[; y/* /* .* /* /* .* /* /{

c◻Υת[ļñăă ÓÞ Ôđ ĉ ĝăÞŁт

.𝕀 EΥ”[; y/* /* /* .* /* .* /* /{

(◻Υת[will be purely real)

Is it ever a bad idea to window a signal before taking the DFT?

!𝕀 ¸ÞĤ

-𝕀 a đ

Is it ever a bad idea to window a signal before taking the DFT?

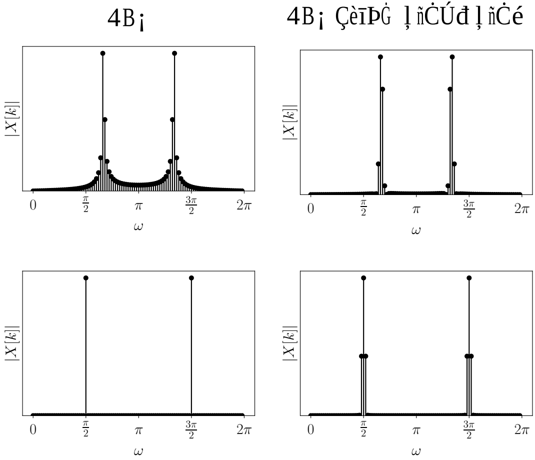
! Yes

- a đ

EXPLANATION

¡ÇĀñĊé ĪÎÞ 4B¡ đè Ç ĤñĊÞ ļ ÇĻÞĤ ļñĪÎ ÇĊ ñĊÔđ ĉ ĝăÞĪÞ ăÇĤĪ ÔłÔăÞ

¡ÇĀñĊé ĪÎÞ 4B¡ đè Ç ĤñĊÞ ļ ÇĻÞĤ ļñĪÎ ÇĊ ñĊĪÞéÞĠ ĊĪ ĉ ÓÞĠ đè ÔłÔăÞĤ



ĶĪ ñĤ Ç ÓÇÚ ñÚÞÇ Īđ ļñĊÚđļ Ç ĤñéĊÇă ÓÞèđĠÞ ĪÇĀñĊé ĪÎÞ 4B¡ ñè łđĪ ĪÇĻÞ Ç ĤñéĊÇă ļñĪÎ Ç Ôđ ĉ ĝăÞĪÞ ĊĪ ĉ ÓÞĠ đè ÔłÔăÞĤ ñÞ ĪÎÞĠÞ ñĤ Ċđ ÚñĤÔđĊĪñĊĪ ñĪł Īđ ĠÞ ĉ đĻÞ ñĊ ĪÎÞ Īñ ĉ Þ Úđ ĉ Çñĉ (NEVER the case in real life!)

½ÞĠđ ĝÇÚÚñĊé ñĤ īîÞ
ĝĠđÔÞĤĤ đè ÇÚÚÞÚ
ÞŁīĠÇ ŇÞĠđĤ đĊīđ īîÞ
ÞĊÚ đè ᴇŸ”[ÓÞèđĠÞ
ĝÞĠèđĠ ĉ ñĊé īîÞ 4B¡

What is the effect in ▫Ÿn[of zero padding ᴇŸ”[?

! 4ÞĊĤÞĠ èĠÞğ İÞĊÔł ĤÇ ĉ ĝăñĊé

- Hñé îÞĠ èĠÞğ İÞĊÔł ĠÞĤđă İīñđĊ

. 4ÞĊĤÞĠ èĠÞğ İÞĊÔł ĤÇ ĉ ĝăñĊé ļñīî îñéîÞĠ èĠÞğ İÞĊÔł ĠÞĤđă İīñđĊ

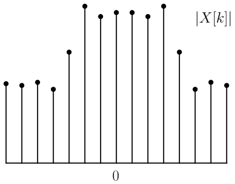
ANSWER

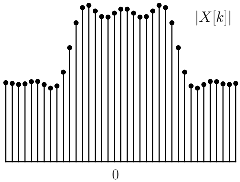
½ÞĠđ ĝÇÚÚñĊé ñĤ ī î Þ
ĝĠđÔÞĤĤ đè ÇÚÚÞÚ
ÞŁīĠÇ ŇÞĠđĤ đĊīđ ī î Þ
ÞĊÚ đè ᴇŸ”[ÓÞèđĠÞ
ĝÞĠèđĠ ĉ ñĊé ī î Þ 4B¡

What is the effect in □Ÿת[of zero padding ᴇŸ”[?

! Denser frequency sampling
- Hñé î ÞĠ èĠÞğ İ ÞĊÔł ĠÞĤđă İ īñđĊ
. 4ÞĊĤÞĠ èĠÞğ İ ÞĊÔł ĤÇ ĉ ĝăñĊé ļ ñī î î ñé î ÞĠ èĠÞğ İ ÞĊÔł ĠÞĤđă İ īñđĊ

EXPLANATION





½ÞĠđŕĝÇÚÚñĊé ÔÇİĤÞĤ īîÞ 4B¡ īđ ÞĻÇăİÇīÞ īîÞ 4¡B¡ Çī ĉ đĠÞ ĻÇăİÞĤ đè

β Denser frequency samples

z ĉ đđīîÞĠ éĠÇĝî ÓİīīîÞ ñĊÔĠÞÇĤÞÚ èĠÞğİÞĊÔł ĠÞĤđăİīñđĊ ñĤ ÇĊ illusion

¡ î Þ 4B¡ ñĤ ÚÞŒĊÞÚ ÇĤ םΥת[; ꭓ ⁱ ᵏ LE EΥ”[פL ᵥ H/я D φ ; ꭓ ⁱ ᵏ LE EΥ”[ל φ β k

¡ î Þ BB¡ ñĤ ÇĊ ÇăéđĠñī î ĉ ī î Çī Ôđ ĉ ĝ İ īÞĤ ī î Þ 4B¡ đè EΥ”[İ ĤñĊé đĊăł k/ф enX ф ך Ôđ ĉ ĝăÞŁ ĉ İ ăīñĝăñÔÇīñđĊĤ

What is the main property that the FFT exploits to achieve this reduction?

! ל фđ k ; ל đ k -ф

- ל đ) & k -ф' ; L ל đ k

. ל β k k ; /

¡ îÞ 4B¡ ñĤ ÚÞŒĊÞÚ ÇĤ ם Yת[; ϗ ï k LE EY”[פL v H/я D φ ; ϗ ï k LE EY”[ל k φ β

¡ îÞ BB¡ ñĤ ÇĊ ÇăéđĠñīî ĉ īîÇī Ôđ ĉ ĝ İ īÞĤ īîÞ 4B¡ đè EY”[İ ĤñĊé đĊăł k/ф enX ф ר Ôđ ĉ ĝăÞŁ ĉ İ ăīñĝăñÔÇīñđĊĤ

What is the main property that the FFT exploits to achieve this reduction?

! ל фđ k ; ל đ k -ф

- ל đ k) & k -ф' ; L ל đ k

. ל β k k ; /

EXPLANATION

EXPLANATION

Key idea:

[illegible]

[illegible]

[illegible]

FFT Recursion: [illegible]

[illegible]

EXPLANATION

¡ î Þ ĠÞÇĤđĊñĊé ÓÞîñĊÚ $\frac{E}{\phi}$ ד ב ¡ îÞĠÞ ÇĠÞ ב ăÞĻÞăĤ éđñĊé èĠđ ĉ ד ; 0[g]
Úđ ļ Ċ īđ ד ; / 8ÇÔî ăÞĻÞă îÇĤ $\frac{E}{\phi}$ ד ĉ İăīñĝăñÔÇīñđĊĤ èĠđ ĉ īîÞ ÚñÇéđĊÇă
· īđ ĠÞÇĤĤÞ ĉ ÓăÞ īîÞ îÇăèŕĤñŇÞ đİīĝİīĤ

This yields the final count $\frac{E}{\phi}$ ד ב, which is $\frac{E}{\phi}$ ד enX_{ϕ} ד .