Imperial College London

MODULE 6 & 7 CLASS

Aidan Hogg & Patrick Naylor - Autumn Term 2020
ELEC50013: Signal and Systems
Department of Electrical and Electronic Engineering

Method:

o . đĊÔÞĝīİÇă ğİÞĤīñđĊ ĝđĤÞÚ ŕ Ĥīİ ÚÞĊīĤ ñĊÚñĻñÚİÇăăł Ôđ ĉ Þ İĝ ñĊñīñÇă ÇĊĤ ļ ÞĠ (5 mins)

π 8ŁĝăÇĊÇīñđĊдÚñĤÔİĤĤñđĊ đè ÔđĠĠÞÔī ÇĊĤ ļ ÞĠ (5 mins)

QUESTION 1:

. đĊĤñÚÞĠ Ç ÚñĤÔĠÞīÞŕīñ ĉ Þ ĤłĤīÞ ĉ
ļ ñī î ī î Þ èđăăđ ļ ñĊé èĠÞğ İ ÞĊÔł
ĠÞĤĝđĊĤÞ

What system gives this frequency response?

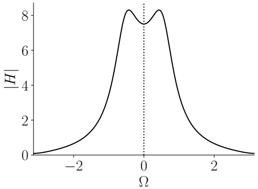
!   -   .

. đĊĤñÚÞĠ Ç ÚñĤÔĠÞīÞŕīñ ĉ Þ ĤłĤīÞ ĉ
ļ ñīî īîÞ èđăäđ ļ ñĊé èĠÞğ İ ÞĊÔł
ĠÞĤĝđĊĤÞ

What system gives this frequency response?

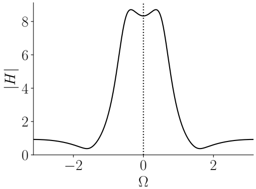
! - .

Frequency responses:



!

B



.

QUESTION 2:

. đĊĤñÚÞĠ ÇĊ Z¡K ĤłĤīÞ ĉ đĝÞĠÇīñĊé ļñīî ĤÇ ĉ ĝăñĊé èĠÞğ İÞĊÔł oξ ĀHŇ ÇĊÚ ĤłĤīÞ ĉ èİĊÔīñđĊ

. &į' ; į LE

Determine the group delay of . &į'

!ǁ o zÇ ĉ ĝăÞ

-ǁ o zÞÔđĊÚ

.ǁ o vÇÚñÇĊĤ ĝÞĠ ĤÞÔđĊÚ

ANSWER

[RELATED LECTURE EXERCISES: 1 (M7)]

. đĊĤñÚÞĠ ÇĊ Z¡K ĤłĤīÞ ĉ đĝÞĠÇīñĊé ļñīî ĤÇ ĉ ĝăñĊé èĠÞğ İÞĊÔł oξ ĀHŇ ÇĊÚ ĤłĤīÞ ĉ èİĊÔīñđĊ

. &į ' ; į LE

Determine the group delay of . &į '

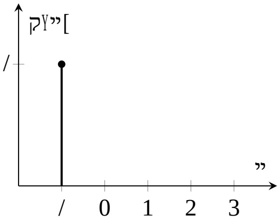
!⃒ o zÇ ĉ ĝăÞ

-⃒ o zÞÔđĊÚ

.⃒ o vÇÚñÇĊĤ ĝÞĠ ĤÞÔđĊÚ

EXPLANATION

gĊÞ ļ Çł īđ ĤđăĻÞ ī î ñĤ . &į ' ; į ^{LE} № ꝗϒ”[; ϒ” L /[



. đĊĤÞğ İ ÞĊīăł ī î Þ ÚñèèÞĠÞĊÔÞ Þğ İ ÇīñđĊ ñĤ

зϒ”[; ᴇϒ” L /[

¡ î ÞĠÞèđĠÞ ī î Þ éĠđ İ ĝ ÚÞăÇł ñĤ o ĤÇ ĉ ĝăÞ đĠ одоξξξξ ҕ ξo ĉ Ĥ

EXPLANATION

QUESTION 3:

. đĊĤñÚÞĠ īîÞ èđăăđ ļ ñĊé ļ ñĊÚđ ļ Ĥ

vÞÔīÇĊé İ ăÇĠ   HÇ ĉ ĉ ñĊé   -ăÇÔĀ ĉ ÇĊŕHÇĠĠñĤ

If we were to design a filter using the windowing method, which window should be selected if we only care about the transition bandwidth being narrow?

! vÞÔīÇĊé İ ăÇĠ

- HÇ ĉ ĉ ñĊé

. -ăÇÔĀ ĉ ÇĊŕHÇĠĠñĤ

. đĊĤñÚÞĠ ī î Þ èđăăđ ļ ñĊé ļ ñĊÚđ ļ Ĥ

vÞÔīÇĊé İăÇĠ HÇ ĉ ĉ ñĊé -ăÇÔĀ ĉ ÇĊŕHÇĠĠñĤ

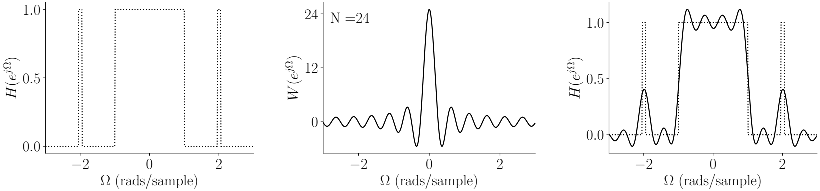
If we were to design a filter using the windowing method, which window should be selected if we only care about the transition bandwidth being narrow?

! vÞÔīÇĊé İăÇĠ

- HÇ ĉ ĉ ñĊé

. -ăÇÔĀ ĉ ÇĊŕHÇĠĠñĤ

Window Relationships



QUESTION 4:

vÞÔÇăă ĪîÇĪ Ç ÚñéñĪÇă ĤłĤĪÞ ĉ ñĊ éÞĊÞĠÇă ñĤ ÚÞĤÔĠñÓÞÚ Ół Ç ÚñèèÞĠÞĊÔÞ Þğ İÇĪñđĊ ļ îÞĠÞ Ç ĠÞÔİĠĤñĻÞ ÚñèèÞĠÞĊÔÞ Þğ İÇĪñđĊ İĤÞĤ ĝÇĤĪ đİĪĝİĪĤ ļ îñăÞ Ç ĊđĊ ĠÞÔİĠĤñĻÞ ÚñèèÞĠÞĊÔÞ Þğ İÇĪñđĊ ÚđÞĤ ĊđĪ

Consider the following statements:

o BKv ŒăĪÞĠĤ ÔÇĊ đĊăł ÓÞ ñ ĉ ĝăÞ ĉ ÞĊĪÞÚ ĊđĊ ĠÞÔİĠĤñĻÞăł ñĊ ĝĠÇÔĪñÔÞ

π KKv ŒăĪÞĠĤ ÔÇĊ đĊăł ÓÞ ñ ĉ ĝăÞ ĉ ÞĊĪÞÚ ĠÞÔİĠĤñĻÞăł ñĊ ĝĠÇÔĪñÔÞ

Which of these statements are true?

! o

- π

. -đĪî o ÇĊÚ π

vÞÔÇăă ĪîÇĪ Ç ÚñéñĪÇă ĤłĤĪÞ ĉ ñĊ éÞĊÞĠÇă ñĤ ÚÞĤÔĠñÓÞÚ Ół Ç ÚñèèÞĠÞĊÔÞ Þğ İÇĪñđĊ ļ îÞĠÞ Ç ĠÞÔ İĠĤñĻÞ ÚñèèÞĠÞĊÔÞ Þğ İÇĪñđĊ İĤÞĤ ĝÇĤĪ đ İĪĝ İĪĤ ļ îñăÞ Ç ĊđĊ ĠÞÔ İĠĤñĻÞ ÚñèèÞĠÞĊÔÞ Þğ İÇĪñđĊ ÚđÞĤ ĊđĪ

Consider the following statements:

o BKv ŒăĪÞĠĤ ÔÇĊ đĊăł ÓÞ ñ ĉ ĝăÞ ĉ ÞĊĪÞÚ ĊđĊ ĠÞÔ İĠĤñĻÞăł ñĊ ĝĠÇÔĪñÔÞ

π KKv ŒăĪÞĠĤ ÔÇĊ đĊăł ÓÞ ñ ĉ ĝăÞ ĉ ÞĊĪÞÚ ĠÞÔ İĠĤñĻÞăł ñĊ ĝĠÇÔĪñÔÞ

Which of these statements are true?

! o

- π

. -đĪî o ÇĊÚ π

EXPLANATION

. đĊĤñÚÞĠ ī î ñĤ BĶv ŒăīÞĠ ÚÞĤÔĠñÓÞÚ Ół Ç ĊđĊ ĠÞÔ İ ĠĤñĻÞ ÚñèèÞĠÞĊÔÞ Þğ İ ÇīñđĊ

3Ÿ”[; EŸ”[ ) EŸ” L /[ ) U) EŸ” L 3.[cÇT

3Ÿ” L /[; EŸ” L /[ ) EŸ” L 0[ ) U) EŸ” L 3/[cÓT

3Ÿ”[L 3Ÿ” L /[; EŸ”[L EŸ” L 3/[cÇT ŕ cÓT

3Ÿ”[; 3Ÿ” L /[ ) EŸ”[L EŸ” L 3/[Recursive

cÇT BĶv ŒăīÞĠĤ ÇĠÞ ĊđĠ ĉ Çăăł ñ ĉ ĝăÞ ĉ ÞĊīÞÚ ĊđĊ ĠÞÔ İ ĠĤñĻÞăł Ó İ ī ÔÇĊ ÓÞ ñ ĉ ĝăÞ ĉ ÞĊīÞÚ ĠÞÔ İ ĠĤñĻÞăł

cÓT ĶĶv ŒăīÞĠĤ ÔÇĊ đĊăł ÓÞ ñ ĉ ĝăÞ ĉ ÞĊīÞÚ ĠÞÔ İ ĠĤñĻÞăł ñĊ ĝĠÇÔīñÔÞ ÓÞÔÇ İ ĤÞ ÇĊ ñĊŒĊñīÞ Ċ İ ĉ ÓÞĠ đè ÔđÞèŒÔñÞĊīĤ ļ đ İ ăÚ ÓÞ ĠÞğ İ ñĠÞÚ īđ ĠÞÇăñŇÞ ī î Þ ĉ ĊđĊ ĠÞÔ İ ĠĤñĻÞăł cĠÞÔÇăă 3Ÿ”[; ẞ Ü ; L Ü EŸ[Ÿ” L [T

QUESTION 5:

! BñĊñīÞ Ꮶ ĉ ĝ İ ăĤÞ vÞĤĝđĊĤÞ cBKvт ŒăīÞĠ ÚÞĊđīÞÚ ¯ &ḷ ' ḷ ñīî ñĊĝ İ ī ם &ḷ '
îÇĤ đ İ īĝ İ ī מ &ḷ ' ; ¯ &ḷ ' ם &ḷ '

Which of these filters will have linear phase?

! ʊ$_E$ Ÿ”[; y/* .* /* .* .* /* .* /{

- ʊ$_ф$ Ÿ”[; y/* /* /* .* .* L/* L/* L/{

. ʊ$_o$ Ÿ”[; y/* /* .* /* /* /* /* .* /{

4 ʊ$_ƨ$ Ÿ”[; y.* /* .* /* .* .* L/* .* L/{

ANSWER

[illegible]

Which of these filters will have linear phase?

[illegible]

[illegible]

[illegible]

[illegible]

Linear Phase Filters

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Important: [illegible]