





FAKULTEIT INGENIERSWESE
FACULTY OF ENGINEERING



Stelsels en Seine 414 <i>Systems and Signals 414</i>		Eerste Toets 27 Maart 2013 <i>First Test</i> 27 March 2013	
Tydsduur <i>Duration</i>	1.5 h	Volpunte <i>Full marks</i>	50
Eksaminator: <i>Examiner:</i>		Mede-eksaminator(e): <i>Co-examiner(s):</i>	
T.R. Niesler		R. Wolhuter	

Sertifisering
Certification

Opgestel: Set:	Gemodereer: Moderated:
	
Eksaminator Examiner	Mede-eksaminator Co-examiner

Kandidaatinligting
Candidate's particulars

Van: <i>Surname:</i>	
Voorname: <i>First Names:</i>	
Studentenommer: <i>Student number:</i>	
Handtekening: <i>Signature:</i>	

Lees asseblief noukeurig die instruksies op die volgende bladsy.
Please read instructions on the next page carefully.

INSTRUKSIES

- *Vul u naam en studentenommer in soos aangedui op die voorblad van hierdie vraestel !*
- Lees die inligting op beide hierdie vraestel en die meegaande eksamenboek. Verskaf u gegewens op beide.
- Gee u antwoorde op die beskikbare plek onderaan elke vraag *op die vraestel*. **Die meegaande eksamenboek is beskikbaar net vir rofwerk en word nie gemerk nie.**
- U mag u voorgeskrewe handboek, Proakis & Manolakis sowel as die klasnotas soos in die lesings uitgedeel raadpleeg. Normale notas/kommentaar daarin is in orde. Geen verdere notas (ook nie in 'n sakrekenaar) word toegelaat nie.
- Toon en motiveer u redenasies altdy volledig. ***Punte sal afgetrek word indien dit nie gedoen word nie.*** Omskryf in woorde wat u probeer doen - dit tel in u guns indien u nie 'n berekening suksesvol deurvoer nie.
- Waar gegewens na u mening ontbreek, maak sinvolle, gemotiveerde aannames.
- Skryf met 'n pen. Sketse kan egter in potlood gemaak word.
- Plaas die voltooide vraestel in die rofwerkboek en handig beide (volledig) in.

INSTRUCTIONS

- *Fill in your name and student number in the space provided on the cover of this question paper!*
- Read the information on this question paper and on the accompanying examination book. Provide your details on both.
- Provide your answers in the space allocated after each question *on this question paper*. **The accompanying examination book is for rough-work only and will not be marked.**
- You may consult the prescribed handbook, Proakis & Manolakis as well as the handouts given in class. Normal notes/comments in it are acceptable. All further notes (also in a calculator) are forbidden.
- Always show and motivate your reasoning fully. ***Marks will be deducted for failing to do so.*** Describe what you are trying to do - this counts in your favour with unsuccessful calculations.
- If in your opinion any information is missing, make reasonable, motivated assumptions.
- Write with a pen. Sketches may be in pencil.
- Put the completed question paper inside the rough-work book and hand both (everything) in.

FOR MARKING PURPOSES ONLY

Question	1	2	3	4	5	6	7	8	9	10	11	12	Tot
Mark													
Check													

TOTAL:

Vraag 1 Beskou die volgende diskrete-tyd sein $x[n]$.

Question 1 Consider the following discrete-time signal $x[n]$.

$$x[n] = \begin{cases} 1 & \text{vir/for } n = -2, n = 0 \text{ en/and } n = 2 \\ 0 & \text{elders/otherwise} \end{cases}$$

Bepaal 'n reële geslote-vorm uitdrukking van die Fourier transform $X(\omega)$ vir hierdie sein, waar ω die frekwensie in radiale/monster is. Skets dan die amplitude en fase van u resultaat oor die bereik $-2\pi \leq \omega \leq 2\pi$. Dui asse, amplitudes en frekwensies deeglik aan. Toon en motiveer u berekening. (9)

Determine a real closed-form expression for the Fourier transform $X(\omega)$ of this signal, where ω is the frequency in radians/sample. Then sketch the magnitude and phase of your answer over the interval $-2\pi \leq \omega \leq 2\pi$. Label axes, amplitudes and frequencies thoroughly. Show and motivate your calculations. (9)

Vraag 1 (vervolg)

berekenings.

Addisionele ruimte vir

Question 1 (continued)

working.

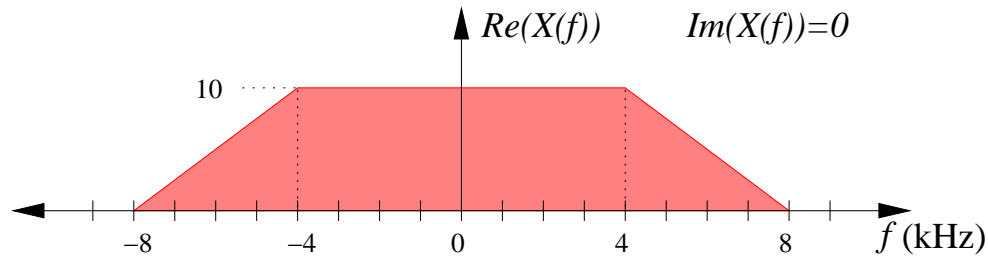
Additional space for

Vraag 1 totaal: 9 punte.

Question 1 total: 9 marks.

Vraag 2 Beskou die bandbeperkte kontinue-tyd sein $x(t)$ met die volgende spektrum (Fourier transform) $X(f)$.

Question 2 Consider the bandlimited continuous-time signal $x(t)$ that has the following spectrum (Fourier transform) $X(f)$.



'n Diskrete-tyd sein $x[n]$ word verkry deur die kontinue-tyd sein $x(t)$ teen 'n monsterfrekwensie van $f_s = 10\text{kHz}$ te monster. Skets die spektrum $X(f_\omega)$ van die gemonsterde sein $x[n]$ oor die interval $-1 < f_\omega < 1$, waar f_ω die frekwensie in siklusse/monster is. Dui asse, amplitudes en frekwensies deeglik aan. Toon en motiveer u berekeninge. (8)

A discrete-time signal $x[n]$ is obtained by sampling the continuous-time signal $x(t)$ at a sampling frequency $f_s = 10\text{kHz}$. Sketch the spectrum $X(f_\omega)$ of the sampled signal $x[n]$ over the interval $-1 < f_\omega < 1$, where f_ω is the frequency in cycles/sample. Label axes, amplitudes and frequencies thoroughly. Show and motivate your calculations. (8)

Vraag 2 (vervolg)

Addisionele ruimte vir berekenings.

Question 2 (continued)

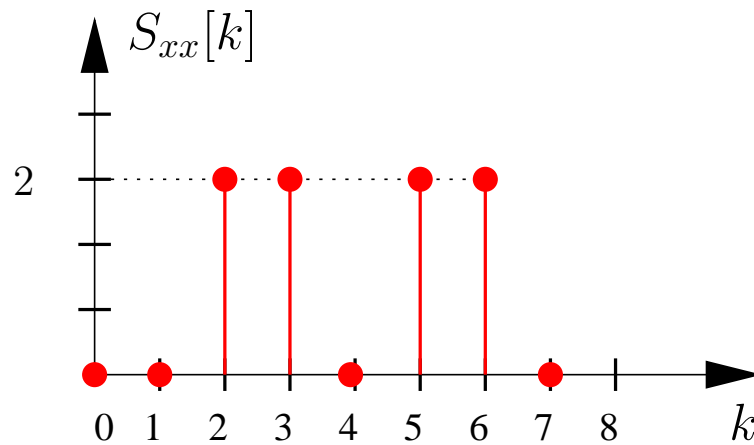
Additional space for working.

Vraag 2 totaal: 8 punte.

Question 2 total: 8 marks.

Vraag 3 Beskou die skets van die 8-punt drywingsdigtheidspektrum $S_{xx}[k]$ van 'n periodesiese diskrete-tyd sein $x[n]$.

Question 3 Consider the graph of the 8-point power density spectrum $S_{xx}[k]$ of a periodic discrete-time signal $x[n]$.



Watter van die volgende kontinue-tyd seine $x(t)$ sou NIE lei na die drywingsdigtheidspektrum hierbo nie as dit gemonster word teen $f_s = 40\text{Hz}$? Daar mag meer as een wees! Toon en motiveer u berekeninge. (10)

Which of the following continuous-time signals $x(t)$ would NOT lead to the above power density spectrum when sampled at $f_s = 40\text{Hz}$? There may be more than one! Show and motivate your calculations. (10)

- (a) $x(t) = \sin(30\pi t) + \cos(60\pi t)$
- (b) $x(t) = \cos(30\pi t) + \sin(70\pi t)$
- (c) $x(t) = \cos(50\pi t) + 0.5 \sin(60\pi t) - 0.5 \sin(100\pi t)$

Vraag 3 (vervolg)

berekenings.

Addisionele ruimte vir

Question 3 (continued)

working.

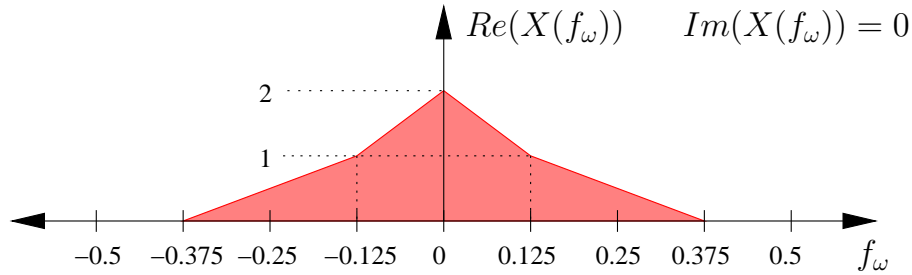
Additional space for

Vraag 3 totaal: 10 punte.

Question 3 total: 10 marks.

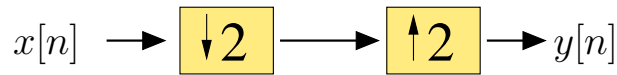
Vraag 4 Beskou die diskrete-tyd sein $x[n]$ met die volgende spektrum (Fourier transform) $X(f_\omega)$, waar f_ω die frekwensie in sikusse per monster aandui.

Question 4 Consider the discrete-time signal $x[n]$ that has the following spectrum (Fourier transform) $X(f_\omega)$, where f_ω is the frequency in cycles/sample.



Hierdie sein word aangelê op 'n stelsel wat dit afmonster met 'n faktor 2 en dan dadelik weer opmonster met dieselfde faktor.

This signal is applied to a system which down-samples it by a factor 2 and then immediately up-samples it again by the same factor.



Skets die spektrum $Y(f_\omega)$ van die resulterende sein $y[n]$ oor die interval $-1 < f_\omega < 1$, waar f_ω die frekwensie in siklusse/monster is. Dui asse, amplitudes en frekwensies deeglik aan. (8)

Sketch the spectrum $Y(f_\omega)$ of the sampled signal $y[n]$ over the interval $-1 < f_\omega < 1$, where f_ω is the frequency in cycles/sample. Label axes, amplitudes and frequencies thoroughly. (8)

Vraag 4 (vervolg)

Addisionele ruimte vir

berekenings.

Question 4 (continued)

working.

Additional space for

Vraag 4 totaal: 8 punte.

Question 4 total: 8 marks.

Vraag 5 Beskou die volgende diskrete-tyd sein $x[n]$, met α 'n reële konstante.

Question 5 Consider the following discrete-time signal $x[n]$, where α is a real constant.

$$x[n] = \begin{cases} e^{-\alpha n} & \text{vir/for } n \geq 0 \\ 0 & \text{elders/otherwise} \end{cases}$$

a) Bepaal die waardes van α waarvoor $x[n]$ 'n energiesein is. *Wenk:* $\sum_{n=0}^{\infty} r^n = 1/(1-r)$ as $-1 < r < 1$. Toon en motiveer u berekening. (4)

a) Determine the values of α for which $x[n]$ is an energy signal. *Hint:* $\sum_{n=0}^{\infty} r^n = 1/(1-r)$ when $-1 < r < 1$. Show and motivate your calculations. (4)

b) Bepaal die waarde(s) van α waarvoor $x[n]$ 'n drywingssein is. Toon en motiveer u berekening. (2)

b) Determine the value(s) of α for which $x[n]$ is a power signal. Show and motivate your calculations. (2)

c) Bepaal die energie van die sein wanneer $\alpha = 0.4$. Toon en motiveer u berekening. (2)

c) Determine the energy of the signal when $\alpha = 0.4$. Show and motivate your calculations. (2)

Vraag 5 totaal: 8 punte.

Question 5 total: 8 marks.

Vraag 6 Beskou die stelsel wat deur die volgende lineêre konstante-koëffisiënt verskilvergeljing beskryf word:

$$2y[n] - y[n - 1] + 3y[n - 2] = 3x[n] - 2x[n - 1]$$

a) Skets 'n “Direkte-vorm II” blokdiagram van hierdie stelsel. (3)

Question 6 Consider the system described by the following linear constant-coefficient difference equation :

a) Sketch a “Direct-form II” block diagram of this system. (3)

b) Is dit 'n FIR of 'n IIR stelsel ? Motiveer u antwoord. (1)

b) Is this a FIR or an IIR system ? Motivate your answer. (1)

Vraag 6 (vervolg)

c) Bereken die eerste 4 monsters van die stelsel se impulsweergawe $h[n]$. (3)

Question 6 (continued)

c) Calculate the first 4 samples of the system impulse response $h[n]$. (3)

Vraag 6 totaal: 7 punte.**Question 6 total: 7 marks.****Vraestel totaal: 50****Question-paper total: 50**