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Benodigdhede vir hierdie vraestel/Requirements for this paper:			
Multikeusekaarte/ Multi-choice cards:		Nie-programmeerbare sakrekenaar/ Non-programmable calculator:	X
Grafiekpapier/ Graphic paper:		Draagbare Rekenaar/ Laptop:	

Oopboek-eksamen/ Open book examination?	NEE/ NO

EKSAMEN/TOETS EXAMINATION/TEST:	Eksamen (1e) / Examination (1st)	KWALIFIKASIE/ QUALIFICATION:	B Ing / B Eng
MODULEKODE/ MODULE CODE:	EERI 418	TYDSDUUR/ DURATION:	3 ure/hours
MODULEBESKRYWING/ MODULE DESCRIPTION:	Beheerteorie II Control theory II	MAKS/ MAX:	100
EKSAMINATORE(E)/ EXAMINER(S):	PROF. KR UREN PROF. G VAN SCHOOR	DATUM/ DATE:	10/06/2015
		TYD/TIME:	09:00
MODERATOR:	DR. F DU PLESSIS (UJ)		

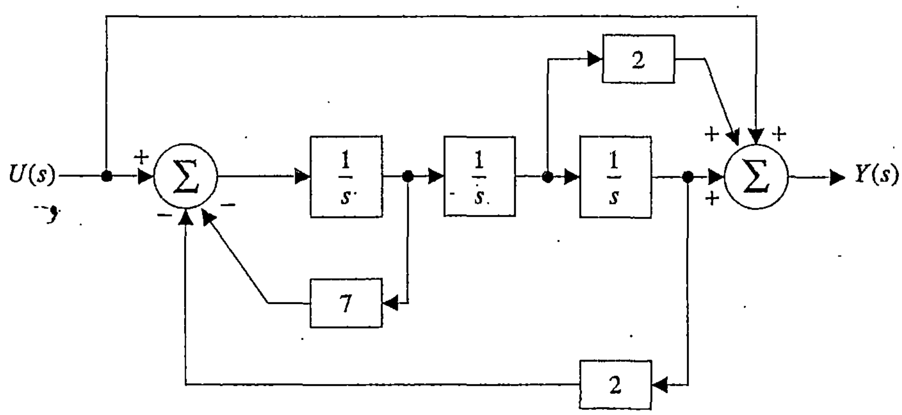
TOTAAL/TOTAL: 100

VRAAG 1/ QUESTION 1

Beskou die blokdiagram van 'n stelsel in Figuur 1: / *Consider the block diagram of a system in Figure 1.*

1.1 Lei 'n toestandsveranderlike model vir die stelsel af. / *Derive a state variable model of the system.* (4)

1.2 Bepaal of die stelsel beheerbaar en waarneembaar is. / *Determine if the system is controllable and observable.* (6)



Figuur / *Figure* 1

[10]

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VRAAG 2 / QUESTION 2

2.1 'n Stelsel word deur die volgende verskilvergelyking gemodelleer: /

A system is modelled by the following difference equation:

$$x(k+2)-1.3x(k+1)+0.36x(k)=e(k)$$

Bepaal die oordragsfunksie van die stelsel $\left(\dfrac{X(z)}{E(z)}\right)$. /

Determine the transfer function of the system $\left(\dfrac{X(z)}{E(z)}\right)$. (4)

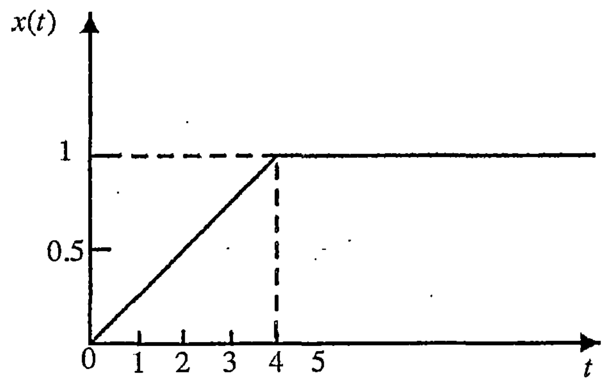
2.2 Bepaal $x(k)$ vir die stelsel in 2.1 vir 'n eenheidstrapinset deur van magreeksuitbreiding gebruik te maak. Aanvaar alle begintoestande as nul en bereken tot die vyfde term $(x(4))$. /

Determine $x(k)$ for the system in 2.1 for a unit step input by using the power series method. Take all initial conditions as zero and determine up to the fifth term $(x(4))$. (5)

2.3 Bepaal $x(k)$ vir die stelsel in 2.1 in geslote vorm vir 'n eenheidstrapinset deur van parsiële breuk uitbreiding gebruik te maak. /

Determine $x(k)$ for the system in 2.1 in closed form for a unit step input using partial fraction expansion. (7)

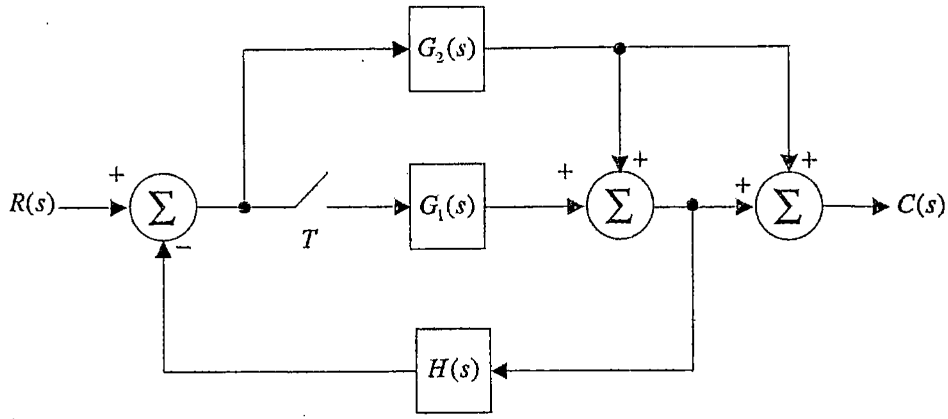
2.4 Bepaal die z-transform (in geslote vorm) van die tydsein $x(t)$ gegee in Figuur 2. Neem aan dat die monstertempo $T=1$ "sek". / *Obtain the z-transform (in closed form) of the curve $x(t)$ shown in Figure 2. Assume that the sampling period is $T=1$ "sec".*



Figuur / *Figure* 2

(6)

2.5 Bepaal vir die stelsel in Figuur 3 die uitset $C(z)$ in terme van die inset en die oordragsfunksies./ *Determine for the system in Figure 3 the output $C(z)$ in terms of the input and the transfer functions.*



Figuur / *Figure* 3

(8)

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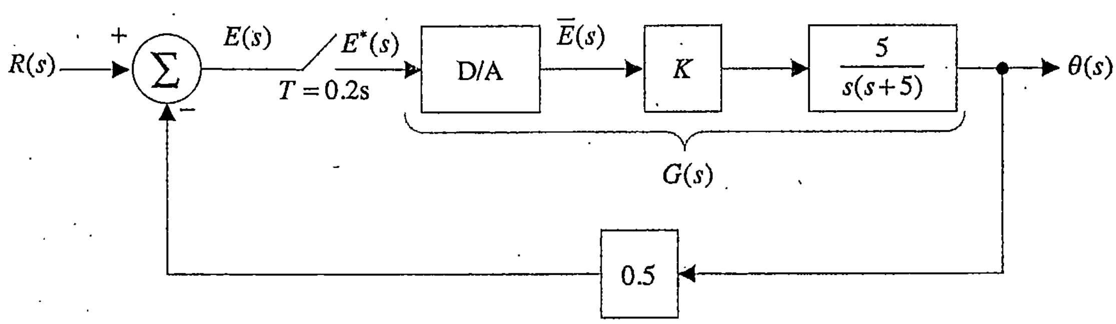
VRAAG 3 / *QUESTION* 3

Beskou die stelsel in Figuur 4. / *Consider the system in Figure 4.*



Figuur / *Figure 4*

3.1 Bepaal die stelseloordragsfunksie $\left(\frac{\theta(z)}{R(z)}\right)$ in terme van $G(z)$. / *Determine the system transfer function* $\left(\frac{\theta(z)}{R(z)}\right)$ *in terms of* $G(z)$.

(1)

3.2 Die oordragsfunksie $G(z)$ word gegee deur: / *The transfer function* $G(z)$ *is given by:*

$$G(z) = \frac{K(0.07358z + 0.05285)}{z^2 - 1.368z + 0.3679}$$

Bepaal die bestendige toestand fout van die diskrete stelsel vir $K = 10$ vir 'n eenheidshellingsinset. / *Determine the steady state error of the discrete system for* $K = 10$ *for a unit ramp input.*

(4)

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3.3 Bepaal die demping asook die natuurlike frekwensie van die diskrete stelsel. / *Determine the damping as well as the natural frequency of the discrete system.*

(5)

3.4 Doen die nodige toetse en spreek jou uit oor die sinvolheid van die keuse van die monsterperiode. / *Do the necessary tests and comment on the choice of the sampling period.*

(5)

3.5 Gebruik die Jury stabiliteitstoets om die bereik van K te bepaal vir stabiliteit. / *Use the Jury stability test to determine the range of* K *for stability.*

(5)

3.6 Bepaal die frekwensie vir marginale stabiliteit. / *Determine the frequency for marginal stability.*

(5)

[25]

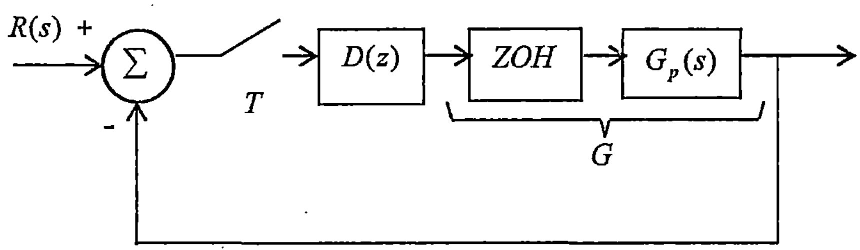
Addisionele inligting / *additional information:*

$$\zeta = \frac{-\ln r}{\sqrt{\ln^2 r + \theta^2}}$$

$$\omega_n = \frac{1}{T}\sqrt{\ln^2 r + \theta^2}$$

$$\tau = \frac{1}{\zeta\omega_n}$$

VRAAG 4 / *QUESTION 4*



Figuur / *Figure* 5

Die stelsel in figuur 3 het die volgende oordragsfunksie: / *The system in figure 5 has the following transfer function:*

$$G_p(s) = \frac{30K}{(s+1)(s+5)}$$

Vir K = 1, is die diskrete oordragsfunksie van die stelsel soos volg: / *For K = 1, the discrete transfer function of the system is as follows:*

$$G(z) = \frac{K(0.005766z + 0.00554)}{z^2 - 1.885z + 0.8869}, \qquad T = 0.02s$$

4.1 Verstel K na 15 om die bestendige toestand foutvereiste te bevredig./ *Adjust K to 15 to satisfy the steady state error requirement.*

Ontwerp 'n fasenaloopnetwerk $D(z)$ in die bodediagramvlak wat 'n fasegrens van 30° tot gevolg sal hê. / *Design a phase lag compensator $D(z)$ in the bode diagram plane that will give a phase margin of 30°.*

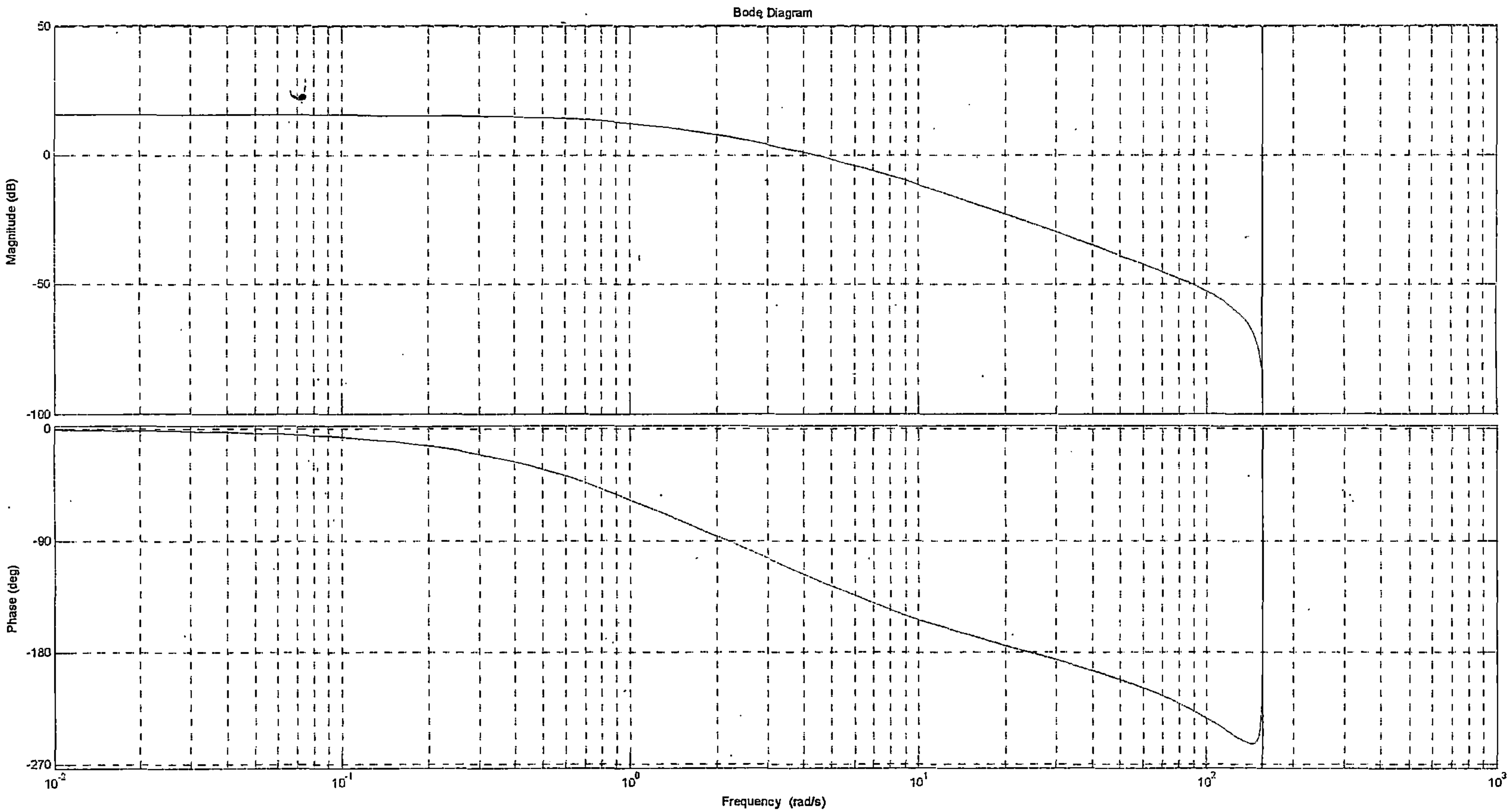
Figuur 6 toon die bodediagram van $G(j\omega)$ vir $K = 1$./ *Figure 6 shows the bode diagram of $G(j\omega)$ for $K = 1$.* (10)

4.2 Die stelsel moet bedryf word by die punt van kritiese demping. Teken die benaderde wortellokus van die stelsel en bepaal die tydkonstante van die stelsel vir die genoemde kondisie. Slegs die gedeelte van die lokus waar kritiese demping voorkom hoef by benadering bereken te word. /
The system must be operated at the point of critical damping. Draw the approximate root locus of the system and determine the time constant of the system for the mentioned condition. Only the part of the root locus where the system is critically damped needs to be determined by approximation.
Ontwerp 'n eenheidswins fase-voorloopkompensator om die tydkonstante van die stelsel (steeds krities gedemp) met 'n faktor 4 te verminder. Dui aan hoe die kompensasie die wortellokus wysig. Wat is die waarde van die wins K waar die gekompenseerde stelsel die verlangde krities gedempte respons en die verlaagde tydkonstante sal lewer. /
Design a unity gain phase lead compensator to reduce the time constant of the system (still critically damped) by a factor 4. Show how the compensation modifies the root locus. What is the value of the system gain K at the point where the compensated system shows the desired critically damped response with the reduced time constant. (15)
[25]

Addisionele inligting / *Additional information:*

$$D(w) = a_0\left[\frac{1+w/(a_0/a_1)}{1+w/(1/b_1)}\right],\quad a_1 = \frac{1-a_0|G(j\omega_{w1})|\cos\theta}{\omega_{w1}|G(j\omega_{w1})|\sin\theta},\quad b_1 = \frac{\cos\theta - a_0|G(j\omega_{w1})|}{\omega_{w1}\sin\theta}$$

$$K_d = a_0\left[\frac{\omega_{wp}(\omega_{w0}+2/T)}{\omega_{w0}(\omega_{wp}+2/T)}\right],\quad z_0 = \left[\frac{2/T-\omega_{w0}}{2/T+\omega_{w0}}\right],\quad z_p = \left[\frac{2/T-\omega_{wp}}{2/T+\omega_{wp}}\right]$$



Figuur / *Figure* 6

VRAAG 5 / *QUESTION 5*

Bespreek Kunsmatige Neurale Netwerke aan die hand van hul oorsprong, struktuur, funksionaliteit en opleiding. Klassifiseer ook die gebruik daarvan in terme van toepassings. /

Discuss Artificial Neural Networks in terms of their origin, structure, functionality and training. Classify their use in terms of applications.

[10]