NORTH-WEST UNIVERSITY ®
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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 uur/hour** |
| **MODULEBESKRYWING/ MODULE DESCRIPTION:** | **Beheerteorie II** | **MAKS/ MAX:** | **100** |
| **EKSAMINATORE(E)/ EXAMINER(S):** | **PROF. G VAN SCHOOR** | **DATUM/ DATE:** | **27/05/2010** |
| | | **TYD/TIME:** | **09:00** |
| **MODERATOR:** | **PROF. MA VAN WYK** | | |

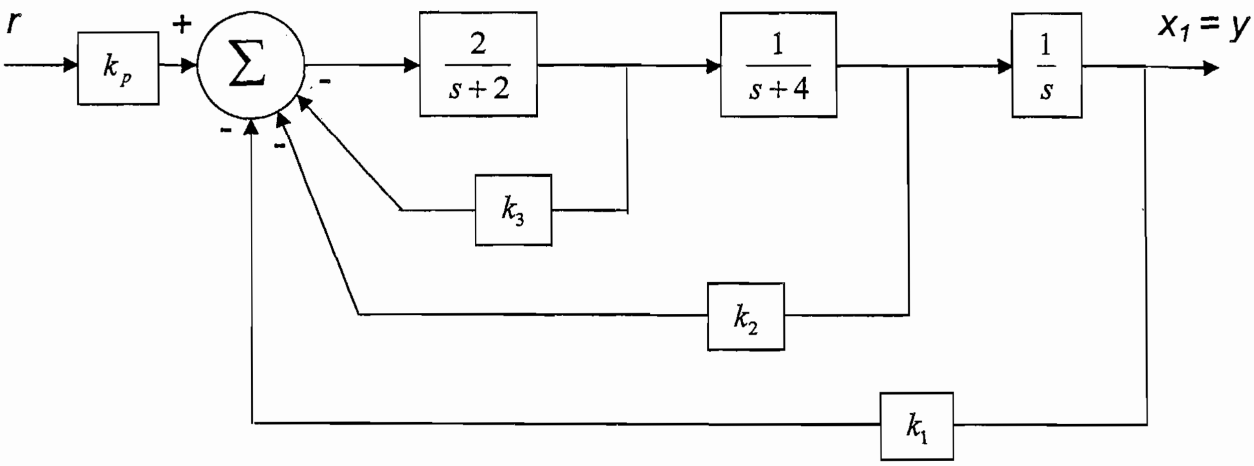
**TOTAAL/TOTAL: 100**

VRAAG 1/ *QUESTION* 1

Die blokdiagram van 'n stelsel met toestandsterugvoer word in figuur 1 getoon. Bepaal die winswaardes $k_1$, $k_2$, $k_3$ en $k_p$ sodat: / *The block diagram of a system with state feedback is shown in figure 1. Determine the gains* $k_1$, $k_2$, $k_3$ *and* $k_p$ *such that:*

*(a)* die bestendige toestand fout vir 'n trapinset nul is / *the steady state error for a step input is zero;*
*(b)* die persentasie verbyskiet kleiner as 5 % is en die vestigingstyd kleiner as 0.5 s is / *the percentage overshoot is less than 5 % and the settling time less than 0.5 s.*

Gebruik die ITAE optimum polinoom metode. / *Use the ITAE optimum polynomial method.*




Figuur / *Figure* 1

[10]

VRAAG 2 / *QUESTION* 2

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

*A system is modelled by the following difference equation:*

$$y(k+2)+6y(k+1)+5y(k)=e(k+1)+2e(k)$$

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

*Determine the transfer function of the system* $\dfrac{Y(z)}{E(z)}$. (4)

2.2 Bepaal *y(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 vierde term (*y(3)*) /

*Determine y(k) for the system in 2.1 for a unit step input. Use the power series method and determine up to the fourth term (y(3)). All initial conditions can be taken as zero.* (5)

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

*Determine y(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 volgende sein: /

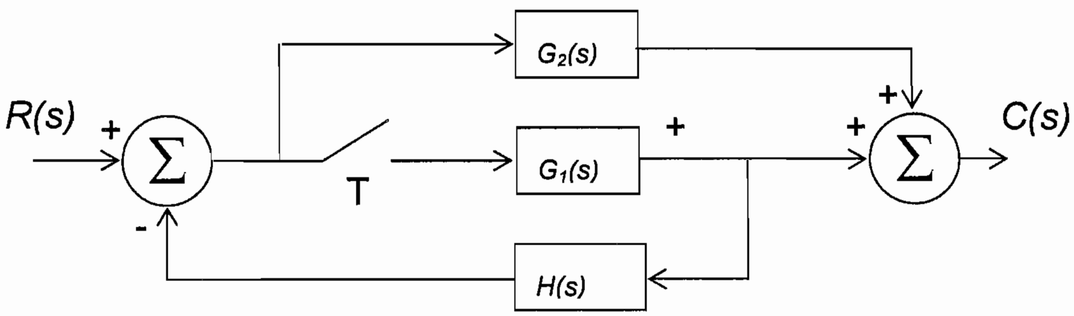
*Determine the z-transform, in closed form, of the following signal:*

$$E(s)=\frac{2(1-e^{-0.5s})e^{-1.1s}}{s(s+1)}, \qquad T=0.5\,s$$

(6)

2.5 Bepaal vir die stelsel in figuur 2 die uitset C(z) in terme van die inset en die oordragsfunksies. /

*Determine for the system in figure 2 the output C(z) in terms of the input and the transfer functions.*




Figuur / *Figure* 2

(8)

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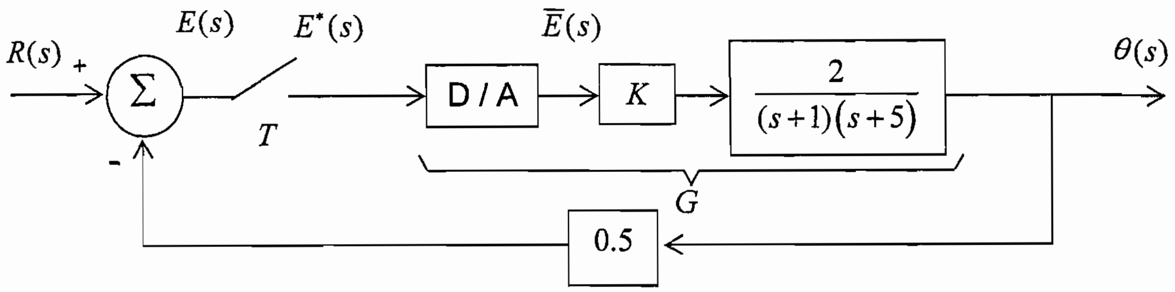
VRAAG 3 / *QUESTION* 3




Figuur / *Figure* 3

Beskou die beheerstelsel in figuur 3. / *Consider the control system in figure 3.*

3.1 Bepaal die stelseloordragsfunksie ($\frac{\theta(z)}{R(z)}$) in terme van *G(z)*. /

*Determine the system transfer function* ($\frac{\theta(z)}{R(z)}$) *in terms of G(z).* (1)

3.2 Bepaal die oordragsfunksie vir $K$ = 10 en $T$ = 0.01 s.

Wat is die tipe van die stelsel? /

*Determine the transfer function for K = 10 and T = 0.01 s.*

Find the system type. (5)

3.3 Bepaal die bestendige toestand fout van die diskrete stelsel vir 'n eenheidstrapinset. /

*Determine the steady state error of the discrete system for a unit step input.* (4)

3.4 Bepaal die demping asook die natuurlike frekwensie van die diskrete stelsel. /

*Determine the damping as well as the natural frequency of the discrete system.* (4)

3.5 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.* (6)

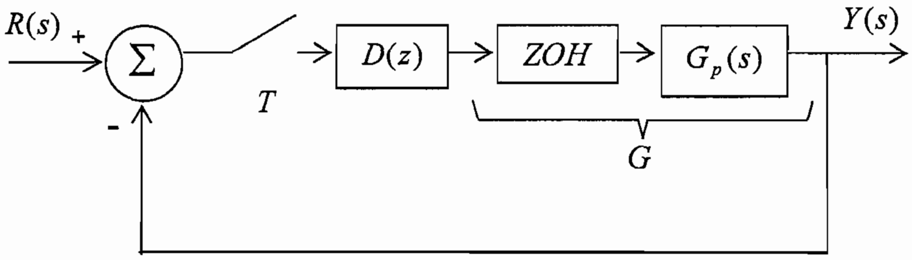
Addisionele inligting / *additional information:*

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

$$\omega_n = \frac{1}{T}\sqrt{\ln^2 r + \theta^2}$$ [20]

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

VRAAG 4 / *QUESTION 4*




Figuur / *Figure* 4

Die stelsel in figuur 4 het die volgende oordragsfunksie: /

*The system in figure 4 has the following transfer function:*

$$G_p(s) = \frac{20K}{s(s+1)(s+4)}$$

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:*

$$G(z) = \frac{3.292\cdot 10^{-6} z^2 + 1.3\cdot 10^{-5} z + 3.211\cdot 10^{-6}}{(z-1)(z-0.99)(z-0.9608)}, \qquad T = 0.01s$$

Figuur 5 toon die bodediagram van G(jω) vir $K = 1$. /

*Figure 5 shows the bode diagram of G(jω) for $K = 1$.*

4.1 Hou $K = 1$ en ontwerp 'n fasenaloopnetwerk *D(z)* wat 'n fasegrens van 45° tot gevolg sal hê, maar nie die bestendige gedrag van die stelsel sal verander nie. /

*Keep $K = 1$ and design a phase lag compensator D(z) that will give a phase margin of 45° for the system without changing the system's steady state performance.*

(10)

4.2 Hou $K = 1$ en ontwerp 'n fasevoorloopnetwerk *D(z)* wat 'n fasegrens van 30° tot gevolg sal hê, maar nie die bestendige gedrag van die stelsel sal verander nie. /

*Keep $K = 1$ and design a phase lead compensator D(z) that will give a phase margin of 30° for the system without changing the system's steady state performance.*

(10)

Addisionele inligting / *additional information:*

$$D(w) = a_0\left[\frac{1 + w/(a_0/a_1)}{1 + w/(1/b_1)}\right]$$

$$a_1 = \frac{1 - a_0|G(j\omega_{w1})|\cos\theta}{\omega_{w1}|G(j\omega_{w1})|\sin\theta}, \quad b_1 = \frac{\cos\theta - a_0|G(j\omega_{w1})|}{\omega_{w1}\sin\theta}$$

[20]

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

VRAAG 5 / *QUESTION 5*

Sê of die volgende stellings **WAAR** of **VALS** is. **EEN** punt sal afgetrek word vir elke verkeerde antwoord. Moet dus nie raai nie; los liewer oop as jy nie weet nie. / *State whether the following statements are **TRUE** or **FALSE**, keeping in mind that **ONE** mark will be deducted for each wrong answer. Therefore do not guess; rather leave blank if you do not know the answer.*

5.1 Die oordragsfunksie van 'n stelsel kan nie bepaal word as die inset van die stelsel deur 'n analoogelement gaan voordat dit gemonster is nie. /

*The transfer function of a system cannot be derived if the input to the system passes through an analog element before being sampled.* (2)

5.2 Die numeriese integrasietegniek het 'n direkte invloed op die grootte van die tydstap in 'n simulasie van 'n stelsel. Hoe hoër die orde van die numeriese integrasietegniek, hoe groter kan die tydstap wees. /

*The numeric integration technique has a direct effect on the size of the time step in a simulation of a system. The higher the order of the integration technique, the larger the time step can be.* (2)

5.3 Die effek van die nul-orde houbaan is om die tipe van die stelsel met een te verhoog. /

*The effect of the zero order hold circuit is to increase the type of the system by 1.* (2)

5.4 Die fase naloop eienskap van die fase naloopkompensator is die eienskap wat gebruik word om die fasegrens van 'n stelsel te vergroot na die velangde waarde. /

*The phase lag property of the phase lag compensator is the property used to increase the phase margin of a system to the value required.* (2)

5.5 Die fase voorloopkompensator kan 'n stelsel se responstyd baie verlaag mits die stelsel nie buite die lineêre gebied bedryf word nie. /

*The phase lead compensator can greatly decrease the response time of a system given that the system is operated within its linear region.* (2)

[10]

VRAAG 6 / *QUESTION 6*

Tref 'n vergelyking tussen Kunsmatige Neurale Netwerke en Wasige Logiese Stelsels aan die hand van hul funksionaliteit en toepassing. /

*Compare artificial neural networks and fuzzy logic systems in terms of their functionality and application.*

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