Semestertoets 3 EERI 418: 12/05/2011 (1)

MEMO

VRAAG 1

1.1
$$\frac{\Theta(z)}{R(z)} = \frac{k \cdot D(z)\, G(z)}{1 + 0{,}2k\, D(z) G(z)}$$

met $D(z) = 1$ en
$$G(z) = \frac{0{,}0117z + 0{,}011}{(z-0{,}95)(z-0{,}86)} = \frac{0{,}0117\,(z+0{,}94)}{(z-0{,}95)(z-0{,}86)}$$ (3)

1.2 Jury stabiliteitstoets:

$$Q(z) = 1 + 0{,}2 \cdot k \cdot \frac{0{,}0117z + 0{,}011}{(z-0{,}95)(z-0{,}86)} = 0$$

$$\therefore (z-0{,}95)(z-0{,}86) + 0{,}2k\,(0{,}0117z + 0{,}011) = 0$$
$$z^2 - 1{,}81z + 0{,}817 + 0{,}00234kz + 0{,}0022k = 0$$
$$z^2 + (0{,}00234k - 1{,}81)z + 0{,}817 + 0{,}0022k = 0$$

① $Q(1) > 0$ $\quad 0{,}007 + 0{,}00454k > 0$

$\therefore k > -1{,}54$. Vermoed $k > 0$

② $(-1)^n Q(-1) > 0$

$(-1)^2 \cdot [1{,}817 + 1{,}81 - 0{,}00014k] > 0$

$\therefore k < 25\,907$

③ $|a_0| < a_n$

$|0{,}817 + 0{,}0022k| < 1$

$k < 83{,}2$. (5)

1.3. Frekwensie vir marginale stabiliteit $k = 83{,}2$

$$Q(z) = z^2 - 1{,}62z + 1$$
$$\therefore z = \frac{1{,}62 \pm \sqrt{1{,}62^2 - 4}}{2} = \frac{1{,}62 \pm j1{,}173}{2}$$
$$= 0{,}81 \pm j\,0{,}5865$$
$$= 1 \angle \pm 0{,}627$$

$\therefore \omega T = 0{,}627$, $T = 0{,}05$ $\therefore \omega = 12{,}54$ rad/s

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1.4. Vir $\zeta = 0{,}707$

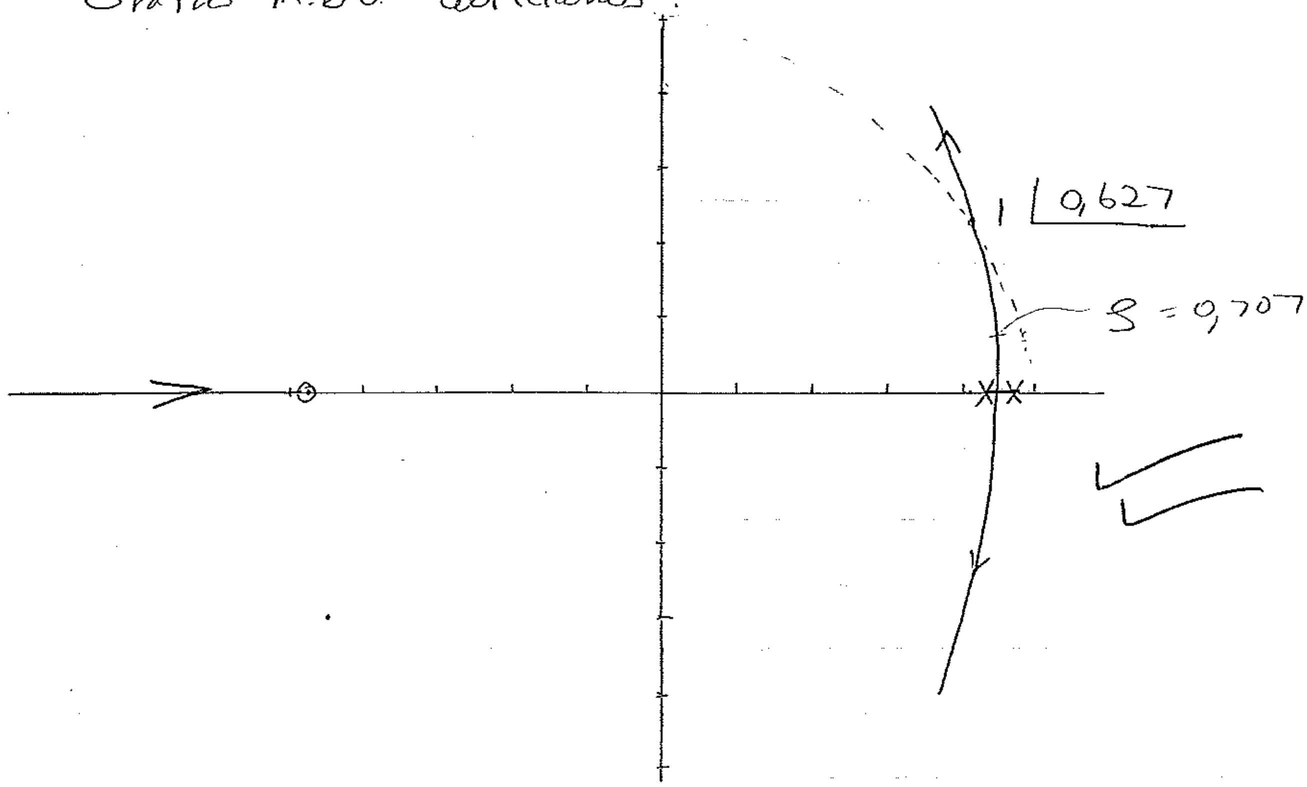
$$z = e^{\sigma T}\angle \sigma T \tan\beta$$

$$\beta = 135^\circ \qquad \tan\beta = -1$$

$$\therefore \quad z = e^{\sigma T}\angle -\sigma T = r\angle\theta$$

Vir wotter waardes van K lê die pole op 'n radius van $e^{\sigma T}$ en 'n hoek van $-\sigma T$

Grafies m.b.v. wortellokus:



Wegbreekpunte: $K = \dfrac{-(z-0{,}95)(z-0{,}86)}{(0{,}2)(0{,}0117z+0{,}011)}$

maks K	0,465	0,462	0,4203	min	$2{,}6\times10^{4}$	$1{,}07\times10^{4}$	$3{,}15\times10^{3}$	$3{,}16\times10^{3}$
z	0,9	0,91	0,89		-1	$-1{,}1$	$-2{,}8$	$-2{,}9$

$z = 0{,}9 \qquad\qquad z = -2{,}8$

By benadering vir $r = e^{\sigma T} = 0{,}825 \quad \sigma T = -0{,}1335 \quad \theta = 11$

pole by $0{,}91 \pm j\,0{,}178$

$$\therefore K = \frac{0{,}19 \cdot 0{,}19}{(0{,}2)(0{,}0117)(1{,}85)} = 8{,}34.$$

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VRAAG 2

Fase voorloopnetwerk

$\angle G(j\omega_{w1}) < -180° + \phi_m = -180° + 40° = -140°$

$|G(j\omega_{w1})| < 1$ onthou 10 dB lig. agv. $k=3$

Dus $\omega_{w1} = 8$ rad/s

$\therefore G(j\omega_{w1}) = 0{,}32 \angle -180°$

Toets $\cos\theta > |G(j\omega_{w1})|$

$\theta = 180° + 40° - (-180°) = 40°$

$\cos 40° > 0{,}32$

$0{,}766 > 0{,}32$ dus Ok

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

$$= \frac{1 - 0{,}32 \cdot \cos 40}{8 \cdot 0{,}32 \cdot \sin 40} = 0{,}4587$$

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

$$= \frac{0{,}766 - 0{,}32}{8 \cdot \sin 40} = 0{,}0867$$

$$D(w) = \frac{1 + 0{,}4587 w}{1 + 0{,}0867 w} = \frac{1 + \frac{w}{2{,}18}}{1 + \frac{w}{11{,}53}}$$

$$\therefore k_d = a_0 \left[\frac{\omega_{wp} (\omega_{wo} + \frac{2}{T})}{\omega_{wo} (\omega_{wp} + \frac{2}{T})} \right] = \frac{209{,}61}{60} = 3{,}492$$

$$z_0 = \frac{\frac{2}{T} - \omega_{wo}}{\frac{2}{T} + \omega_{wo}} = \frac{16 - 2{,}18}{16 + 2{,}18} = 0{,}76$$

$$z_p = \frac{16 - 11{,}53}{16 + 11{,}53} = 0{,}1624$$

$$D(z) = 3{,}492 \frac{(z - 0{,}76)}{(z - 0{,}1624)}$$

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