UNICAMP - UNIVERSIDADE ESTADUAL DE CAMPINAS

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Projeto dos Filtros IIR Digital

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Especificações de Projeto

$fa := 12000$ Frequência de Amostragem

$Ta := \frac{1}{fa} = 8.333333333333 \times 10^{-5}$

Filtro Passa-Baixas

$\xi := 0.7$

$fo := 5$

$klp := 1$

$wo := 2 \cdot \pi \cdot fo = 31.415926535898$

Coeficientes do Numerador

$b_{0\_LP} := 0$

$b_{1\_LP} := \frac{klp \cdot wo^2}{\sqrt{wo^2 - (\xi \cdot wo)^2}} \cdot e^{-\xi \cdot wo \cdot Ta} \cdot \sin\left[Ta \cdot \sqrt{wo^2 - (\xi \cdot wo)^2}\right] \cdot Ta = 6.841339048612 \times 10^{-6}$

Coeficientes do Denominador

$a_{zero\_LP} := 1$

$a_{1\_LP} := -2 \cdot e^{-\xi \cdot wo \cdot Ta} \cdot \cos\left[Ta \cdot \sqrt{wo^2 - (\xi \cdot wo)^2}\right] = -1.996334675843$

$a_{2\_LP} := e^{-2 \cdot \xi \cdot wo \cdot Ta} = 0.996341517186$

Filtro Sintonizado

$ks := 1$

$fb := 1.59$

$B := 2 \cdot \pi \cdot fb = 9.990264638416$

$fc := 360$

$wc := 2 \cdot \pi \cdot fc = 2.261946710585 \times 10^{3}$

Coeficientes do Numerador

$b_{0\_FS} := ks \cdot B \cdot Ta = 8.325220532013 \times 10^{-4}$

$$GH := \frac{ks \cdot B^2 \cdot 0.5}{\sqrt{wc^2 - 0.25 \cdot B^2}} \cdot e^{-0.5 \cdot B \cdot Ta} \cdot \sin\left(Ta \cdot \sqrt{wc^2 - 0.25 \cdot B^2}\right)$$

$$b_{1\_FS} := \left(-ks \cdot B \cdot e^{-0.5 \cdot B \cdot Ta} \cdot \cos\left(Ta \cdot \sqrt{wc^2 - 0.25 \cdot B^2}\right) - GH\right) \cdot Ta$$

Coeficientes do Denominador

$a_{zero\_FS} := 1$

$a_{1\_FS} := -2 \cdot e^{-0.5 \cdot B \cdot Ta} \cdot \cos\left(Ta \cdot \sqrt{wc^2 - 0.25 \cdot B^2}\right) = -1.963757068016$

$a_{2\_FS} := e^{-B \cdot Ta} = 0.999167824397$

Controlador Tipo 3

$R_1 := 6.975 \cdot 10^{3}$

$R_2 := 1.448 \cdot 10^{5}$

$R_3 := 223.785$

$C_1 := 3.116 \cdot 10^{-9}$

$C_2 := 1 \cdot 10^{-10}$

$C_3 := 6.268 \cdot 10^{-8}$

$n_{zero} := 1$

$n_1 := R_2 \cdot C_1 + R_1 \cdot C_3 + R_3 \cdot C_3 = 9.024166438 \times 10^{-4}$

$n_2 := R_2 \cdot C_1 \cdot C_3 \cdot \left(R_1 + R_3\right) = 2.035889496191 \times 10^{-7}$

$d_0 := 0$

$$d_1 := R_1 \cdot (C_1 + C_2) = 2.24316 \times 10^{-5}$$

$$d_2 := R_1 \cdot R_3 \cdot C_3 \cdot (C_1 + C_2) + R_1 \cdot R_2 \cdot C_1 \cdot C_2 = 6.293543173841 \times 10^{-10}$$

$$d_3 := R_1 \cdot R_2 \cdot R_3 \cdot C_1 \cdot C_2 \cdot C_3 = 4.41438475807 \times 10^{-15}$$

Coeficientes do Numerador

$$b_{0\_c} := \frac{n_2 \cdot Ta + n_1 \cdot Ta^2 + n_{zero} \cdot Ta^3}{d_3 + d_2 \cdot Ta + d_1 \cdot Ta^2} = 111.981409658918$$

$$b_{1\_c} := \frac{-\left(2 \cdot n_2 \cdot Ta + n_1 \cdot Ta^2\right)}{d_3 + d_2 \cdot Ta + d_1 \cdot Ta^2} = -189.047732528181$$

$$b_{2\_c} := \frac{n_2 \cdot Ta}{d_3 + d_2 \cdot Ta + d_1 \cdot Ta^2} = 79.787898014361$$

Coeficientes do Denominador

$$a_{zero\_c} := 1$$

$$a_{1\_c} := \frac{-\left(3 \cdot d_3 + 2 \cdot d_2 \cdot Ta + d_1 \cdot Ta^2\right)}{\left(d_3 + d_2 \cdot Ta + d_1 \cdot Ta^2\right)} = -1.288168909664$$

$$a_{2\_c} := \frac{3 \cdot d_3 + d_2 \cdot Ta}{d_3 + d_2 \cdot Ta + d_1 \cdot Ta^2} = 0.308929239625$$

$$a_{3\_c} := \frac{-d_3}{\left(d_3 + d_2 \cdot Ta + d_1 \cdot Ta^2\right)} = -0.020760329961$$

Controlador PI

$$k_{PI} := 5$$

$T_{PI} := 1.25 \cdot 10^{-3}$

Coeficientes do Numerador

$b_{0\_PI} := \frac{k_{PI} \cdot Ta}{T_{PI}} + k_{PI} = 5.333333333333$

$b_{1\_PI} := -k_{PI} = -5$

Coeficientes do Denominador

$a_{0\_PI} := 1$

$a_{1\_PI} := -1$

Filtro Notch Modificado

$f_{notch} := 360$ Frequêcnia do Filtro Notch

$f_{BW\_notch} := 4$ Frequência da bando do filtro notch

$fa = 1.2 \times 10^{4}$

$teta := 2 \cdot \pi \cdot \frac{f_{notch}}{fa} = 0.188495559215$

$D_n := e^{-2 \cdot \pi \cdot \frac{f_{BW\_notch}}{2} \cdot \frac{1}{fa}} = 0.998953350569$

$G_n := \frac{1 + D_n^{2}}{2} = 0.998953898306$

$B_n := \left(1 + D_n^{2}\right) \cdot \cos(teta) = 1.962519356744$

Coeficientes do Numerador

$b_{0\_n} := G_n = 0.998953898306$

$b_{1\_n} := -G_n \cdot 2 \cdot \cos(teta) = -1.962519356744$

$b_{2\_n} := 1$

Coeficientes do Denominador

$a_{0\_n} := 1$

$a_{1\_n} := -B_n = -1.962519356744$

$a_{2\_n} := D_n = 0.998953350569$