Session S4

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Rapport APP6
Traitement numérique des signaux III

Michael Deslauriers desm1927

Jérôme Martel marj2430

Département de génie électrique et de génie informatique

Faculté de génie

Université de Sherbrooke

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1 Transformation bilinéaire

Fonction de transfert normalisée

$$H(s) = \frac{A}{S + A}$$

Transformation pour un filtre passe bande

$$s = \frac{s^2 + \omega_\alpha * \omega_\alpha}{(\omega_\beta - \omega_\alpha) * s}$$

Pour un filtre chebyshev type 1, A = 1.965

$$H(s) = \frac{1.965}{\frac{s^2 + \omega_\alpha * \omega_\beta}{(\omega_\beta - \omega_\alpha) * s} + 1.965}$$

Simplifions

$$H(s) = \frac{1.965}{\frac{s^2 + \omega_\alpha * \omega_\beta}{(\omega_\beta - \omega_\alpha) * s} + 1.965} \times \frac{(\omega_\beta - \omega_\alpha) * s}{(\omega_\beta - \omega_\alpha) * s}$$

$$H(s) = \frac{1.965 * (\omega_\beta - \omega_\alpha) * s}{s^2 + \omega_\alpha * \omega_\beta + 1.965 * (\omega_\beta - \omega_\alpha) * s}$$

Transformation bilinéaire pour S

$$s = \frac{2}{T_e} * \frac{z - 1}{z + 1}$$

$$H(z) = \frac{1.965 * (\omega_\beta - \omega_\alpha) * \frac{2}{T_e} * \frac{z-1}{z+1}}{\left(\frac{2}{T_e} * \frac{z-1}{z+1}\right)^2 + \omega_\alpha * \omega_\beta + 1.965 * (\omega_\beta - \omega_\alpha) * \frac{2}{T_e} * \frac{z-1}{z+1}}$$

Simplifions

$$H(z) = \frac{1.965 * (\omega_\beta - \omega_\alpha) * \frac{2}{T_e} * \frac{z-1}{z+1}}{\left(\frac{2}{T_e} * \frac{z-1}{z+1}\right)^2 + \omega_\alpha * \omega_\beta + 1.965 * (\omega_\beta - \omega_\alpha) * \frac{2}{T_e} * \frac{z-1}{z+1}} \times \left(\frac{z+1}{z+1}\right)^2$$

$$H(z) = \frac{1.965 * (\omega_\beta - \omega_\alpha) * \frac{2}{T_e} * (z-1)(z+1)}{\left(\frac{2}{T_e} * (z-1)\right)^2 + \omega_\alpha * \omega_\beta (z+1)^2 + 1.965 * (\omega_\beta - \omega_\alpha) * \frac{2}{T_e} * (z-1)(z+1)}$$

$$H(z) = \frac{3.93 * \frac{\omega_\beta - \omega_\alpha}{T_e} * \left(z^2 - 1\right)}{\left(\frac{4}{T_e^2} * (z^2 - 2z + 1)\right) + \omega_\alpha * \omega_\beta (z^2 + 2z + 1) + 1.965 * (\omega_\beta - \omega_\alpha) * \frac{2}{T_e} * (z^2 - 1)}$$

$$H(z) = \frac{3.93\frac{\omega_\beta - \omega_\alpha}{T_e} z^2 - 3.93\frac{\omega_\beta - \omega_\alpha}{T_e}}{\frac{4}{T_e^2}z^2 - \frac{8}{T_e^2}z + \frac{4}{T_e^2} + \omega_\alpha\omega_\beta z^2 + 2\omega_\alpha\omega_\beta z + \omega_\alpha\omega_\beta + (\omega_\beta - \omega_\alpha)\frac{3.93}{T_e}z^2 - (\omega_\beta - \omega_\alpha)\frac{3.93}{T_e}}$$

$$H(z) = \frac{\left(3.93\frac{\omega_\beta - \omega_\alpha}{T_e}\right) z^2 + \left(-3.93\frac{\omega_\beta - \omega_\alpha}{T_e}\right)}{\left(\frac{4}{T_e^2} + \omega_\alpha\omega_\beta + (\omega_\beta - \omega_\alpha)\frac{3.93}{T_e}\right) z^2 + \left(-\frac{8}{T_e^2} + 2\omega_\alpha\omega_\beta\right) z + \left(\frac{4}{T_e^2} + \omega_\alpha\omega_\beta - (\omega_\beta - \omega_\alpha)\frac{3.93}{T_e}\right)}$$

Nous pouvons trouver les valeurs maquantes

$$T_e = \frac{1}{f_e} = \frac{1}{8000}$$

$$\Omega_\alpha = \frac{2\pi f_\alpha}{f_e}$$

$$\Omega_\beta = \frac{2\pi f_\beta}{f_e}$$

$$\omega_\alpha = \frac{2}{T_e}\tan\left(\frac{\Omega_\alpha}{2}\right) = 0.001143094977998$$

$$\omega_\beta = \frac{2}{T_e}\tan\left(\frac{\Omega_\beta}{2}\right) = 0.001307658218367$$

On peut maintenant trouver les coefficients de notre filtre

$$B_1 = 3.93\frac{\omega_\beta - \omega_\alpha}{T_e} = 1.655637848711896e+08$$

$$B_2 = 0$$

$$B_3 = -3.93\frac{\omega_\beta - \omega_\alpha}{T_e} = -1.655637848711896e+08$$

$$A_1 = \frac{4}{T_e^2} + \omega_\alpha\omega_\beta + (\omega_\beta - \omega_\alpha)\frac{3.93}{T_e} = 1.952215988240464e+09$$

$$A_2 = -\frac{8}{T_e^2} + 2\omega_\alpha\omega_\beta = 2.549304406738550e+09$$

$$A_3 = \frac{4}{T_e^2} + \omega_\alpha\omega_\beta - (\omega_\beta - \omega_\alpha)\frac{3.93}{T_e} = 1.621088418498085e+09$$

On peux finalement diviser tous les coefficients par A_1 afin de simplifier la présentation.

$$B_1 = 0.0848$$

$$B_2 = 0$$

$$B_3 = -0.0848$$

$$A_1 = 1$$

$$A_2 = 1.3059$$

$$A_3 = 0.8304$$