General: All Coefficients Positive

$$a\,S^3 + b\,S^2 + c\,S + d = 0$$

$$x = bc - ad$$

$$a\,S^4 + b\,S^3 + c\,S^2 + d\,S + e = 0$$

$$x = bc - ad \qquad y = dx - b^2e$$

$$a\,S^5 + b\,S^4 + c\,S^3 + d\,S^2 + e\,S + f = 0$$

$$x = bc - ad \qquad y = be - af \qquad z = (dx - by)y - x^2f$$

$$K_P = 0.6*\mathbf{K_P} \qquad K_I = K_P/T_I \qquad K_D = K_P*T_D$$

$$T_I = 0.5*\mathbf{T_P} \qquad T_D = 0.125*\mathbf{T_P}$$

$$A\,e^{+at} + B\,e^{+bt} + N + M\,t$$
$$+ (X+Yj)\,e^{+(x+yj)t} + (X-Yj)\,e^{+(x-yj)t}$$
$$+ (G+Hj)\,e^{+\omega jt} + (G-Hj)\,e^{-\omega jt}$$

$$A\,e^{+at} + B\,e^{+bt} + N + M\,t$$
$$+ 2X\,e^{+xt}\,\mathrm{Cos}[yt] - 2Y\,e^{+xt}\,\mathrm{Sin}[yt]$$
$$+ 2G\,\mathrm{Cos}[\omega t] - 2H\,\mathrm{Sin}[\omega t]$$

$$R = R_o + \Delta R \sin [\omega t] \qquad C = C_o \qquad D = D_o$$

$$Q = K_P E + K_I \int E d\tau + K_D \, dE/dt$$

$$Q = (K_P + K_I/S + K_D S) E$$

$$Q = (K_P + K_I \, TZ/[Z-1] + K_D \, [Z-1]/TZ) E$$

$$dG/dt = H \qquad G_{NEW} = G_{OLD} + \Delta t * H_{OLD}$$

$$O/I = G/(1+GH) = \mathbf{N}/\mathbf{D} \qquad 1+GH = 1+N/D = (N+D)/D$$

$$1 + GH = \frac{K \, (S-Z_1) \, (S-Z_2) \, ::::: \, (S-Z_n)}{(S-P_1) \, (S-P_2) \, ::::: \, (S-P_m)}$$

$$= K \, [\Pi r_Z \angle \Sigma\theta_Z] \, / \, [\Pi r_P \angle \Sigma\theta_P] = R \angle \Theta$$

$$N = N_Z - N_P \qquad N_Z = N + N_P$$

$$\mathbf{D} = N+D \qquad \Sigma \, \Gamma/(S-\lambda) \qquad \Sigma \, \Gamma e^{+\lambda t}$$

$$A S^2 + B S + C = 0$$

$$[-B-\sqrt{[B^2-4AC]}] / [2A] \qquad [-B+\sqrt{[B^2-4AC]}] / [2A]$$

$$F(S) = \mathfrak{I}\,[f(t)] = \int_0^\infty f(t)\, e^{-St}\, dt$$

$$\mathfrak{I}\,[df/dt] = S\,F(S) \qquad \mathfrak{I} \int f d\tau = F(S) / S$$

$$\mathfrak{I}\,[d^2f/dt^2] = S^2\,F(S) \qquad \mathfrak{I}\,[d^3f/dt^3] = S^3\,F(S)$$

$$\mathfrak{I}(\text{Step with Height A}) = A/S$$

$$\mathfrak{I}(\text{Short Duration Pulse}) = AT$$

$$\mathfrak{I}(\text{Sine Wave}) = A\omega/(S^2+\omega^2)$$

$$\mathfrak{I}(\text{Cosine Wave}) = AS/(S^2+\omega^2)$$

$$\mathfrak{I}(\text{Linear Ramp}) = A/S^2$$

$$\mathfrak{I}\,(f[t-T]) = e^{-ST}\,F(S)$$

$$\lim_{t\to\infty} f(t) = \lim_{S\to 0} S\,F(S)$$

$$z = x + y\,j \qquad z = r\angle\theta = re^{j\theta}$$

$$e^{+j\theta} = \cos\theta + j\sin\theta \qquad e^{-j\theta} = \cos\theta - j\sin\theta$$

$$\sin\theta = (e^{+j\theta} - e^{-j\theta})/\,2j \qquad \cos\theta = (e^{+j\theta} + e^{-j\theta})/\,2$$

$$y(t) = \sum_{n=0}^{N} x(n\Delta\tau)\Delta\tau\ h(t-n\Delta\tau)$$

$$y(t) = \int_{0}^{t} x(\tau)\ h(t-\tau)\ d\tau$$

$$Y(S) = X(S)\ \mathbf{H}(S) = X(S)\ TF(S)$$

$$1 + GH = 0 \qquad GH = -1$$

Magnitude 1 Angle 180

$$\frac{M}{N\ (S-a)\ (S-b)\ (S-c)}$$

$$h^{*}(t) = \sum\ h(nT)\ \delta(t-nT)$$

$$H(Z) = \sum\ h(nT)\ Z^{-n} \qquad Z = e^{ST}$$

$$h(t) = \Sigma\ \Gamma\ e^{\lambda t} \qquad H(S) = \Sigma\ \Gamma\ /\ (S-\lambda)$$

$$H(Z) = \Sigma\ \Gamma\ /\ (1 - e^{\lambda T}\ Z^{-1}) \qquad Z = e^{\lambda T}$$

$$DF = [4Q_o]/[\pi E_o]$$

$$DF = 0 \qquad E_o < B$$

$$DF = [4Q_o]/[\pi E_o]\ \sqrt{[1-(B/E_o)^2]} \qquad E_o > B$$

$$B\ \sqrt{2} \qquad [2Q_o]/[\pi B]$$

$$[2Q_o]/[\pi \mathbf{K}] \qquad [2Q_o]/[\pi \mathbf{K}]\ \sqrt{2}$$

$$DF = K \qquad E_o < B$$

$$DF = [2K]/[\pi]\ [\theta + B/E_o\ \mathrm{Cos}(\theta)] \qquad E_o > B$$

$$\theta = \mathrm{Sin}^{-1}\ [B/E_o]$$

$$DF = 0 \qquad E_o < B$$

$$DF = K\ [\ 1 - [2/\pi]\ [\theta + B/E_o\ \mathrm{Cos}(\theta)]\ ] \qquad E_o > B$$

$$\theta = \mathrm{Sin}^{-1}\ [B/E_o]$$

$$DF = K + [4Q_o]/[\pi E_o]$$

$$DF = [4Q_o]/[\pi E_o]\ j \qquad E_o < B$$

$$DF = M + N\ j \qquad E_o > B$$

$$M = [4Q_o]/[\pi E_o]\ \sqrt{[1-(B/E_o)^2]}$$

$$N = [4Q_o]/[\pi E_o]\ (B/E_o)$$

num=[a b :] den=[i j k :]

sys=tf(num den) impulse(sys)

step(sys) num=[n m :] den=[u v w :]

[r,p,k]=residue(num den) state=ss(tf)

q=[A B C D E :] p=roots(q) plot(x,y)

dx/dt = A x + B u y = C x + D u

dg=c2d(g # 'zoh') z=tf('z' #) dh=1/z

s=complex(0.0 w) gh=num/den

num=as+b den=xs^2+ys=z

real(gh) imag(gh)

rlocus(gh) nyquist(gh) bode(gh)

series(A B) feedback(G H)

```
for a=1:b    ?????    end
if(????)    ????      end
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