VOLTERRA - SERIES

$$y(t) = V[u(t)] = \sum_{\alpha=1}^{\infty (k)} \int_{-\infty (0)}^{\infty (M)} \cdots \int g^{\alpha}(\tau_1, \tau_2, \dots \tau_\alpha)\, u(t-\tau_1) \dots u(t-\tau_\alpha)\, d\tau_1 \dots d\tau_\alpha$$

αTH VOLTERRA KERNEL

$= y_0(t) +$

$\int g(\tau)\, u(t-\tau)\, d\tau \; +$ LINEAR CONVOLUTION

$\iint g^2(\tau_1,\tau_2)\, u(t-\tau_1) u(t-\tau_2)\, d\tau_1 d\tau_2 \; +$ HIGHER ORDER CONVOLUTIONS

$\dots$

$$y(n) = \sum_{\alpha=1}^{\infty} \left(\sum \cdots \sum g^{\alpha}(\tau_1, \dots, \tau_\alpha)\, u(t-\tau_1) \dots u(t-\tau_\alpha) \right)$$

E.G.: $y(n) = g^1(0)\, u(n) + g^2(1,1)\, u^2(n-1) + g^2(1,2)\, u(n-1)\, u(n-2) \dots$

PERIODIC INPUTS, FREQUENCY DOMAIN

$u(t)$ PERIODIC
M HARMONICS

$$Y(l) = \sum_{\alpha=1}^{\infty} Y^{\alpha}(l)$$

$$\sum_{k_1, \dots k_{\alpha-1} = -\frac{M}{2}}^{M/2} G^{\alpha}(k_1, \dots, k_{\alpha-1}, k_\alpha)\, U(k_1) \dots U(k_\alpha)$$

αTH VOLTERRA KERNEL IN FREQ. DOMAIN

$$k_\alpha = l - \sum_{i=1}^{\alpha-1} k_i$$

$$l = \sum_{i=1}^{\alpha} k_i$$

VOLTERRA MODELS, PROPERTIES

(1) NATURAL WAY (ADDITIVE) TO TREAT TOGETHER LIN/NL SYSTEMS

(2) PLENTY OF PRACTICALLY IMPORTANT SYSTEMS CAN BE MODELED (FINITE ORDER, FINITE MEMORY)

(3) WIDE CLASS OF NL SYSTEMS CAN BE APPROXIMATED (IN LS SENSE) BY VOLTERRA SERIES

CONTINUOUS FADING MEMORY SYSTEMS
NL