Using superposition with MNA method

Circuit and admittance matrix, by hand or using MNA function from the other worksheet.

```
V1 1 0
R1 1 2
C1 2 0
RT 2 3
CT 2 3
LK 3 4
RK 4 5
CK 5 0
RO 5 0
CO 5 0
```

$$A := \begin{bmatrix} \frac{1}{R1} & -\frac{1}{R1} & 0 & 0 & 0 & 1 \\ -\frac{1}{R1} & \frac{R1\cdot(1+s\cdot CT\cdot RT+s\cdot C1\cdot RT)+RT}{R1\cdot RT} & -\frac{1+s\cdot CT\cdot RT}{RT} & 0 & 0 & 0 \\ 0 & -\frac{1+s\cdot CT\cdot RT}{RT} & \frac{RT\cdot(1+s^2\cdot CT\cdot LK)+s\cdot LK}{s\cdot LK\cdot RT} & -\frac{1}{s\cdot LK} & 0 & 0 \\ 0 & 0 & -\frac{1}{s\cdot LK} & \frac{RK+s\cdot LK}{s\cdot LK\cdot RK} & -\frac{1}{RK} & 0 \\ 0 & 0 & 0 & -\frac{1}{RK} & \frac{RK\cdot(1+s\cdot CO\cdot RO+s\cdot CK\cdot RO)+RO}{RK\cdot RO} & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$\chi := \text{"}\chi\text{"}$

Solve the linear system

$$B := \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & V_1(f,n) \end{bmatrix}^T \qquad V := A^{-1}\cdot B$$

Complex freq

$$s := 0 + i\cdot n\cdot 2\cdot\pi\cdot f \qquad v_2(t,f,n) := V_2$$

Values

$R1 := 327.1\ k\Omega$ $\quad C1 := 200\ pF$ $\quad Vo := 0.8\ V$

$RT := 9\ M\Omega$ $\quad CT := 12.78\ pF$ $\quad LK := 250\ nH$

$RK := 1.5\ \Omega$ $\quad CK := 100\ pF$ $\quad nmax := 8$

$RO := 1\ M\Omega$ $\quad CO := 15\ pF$

Square wave

$$v_1(t,f) := Vo\cdot\operatorname{sign}(\sin(2\cdot\pi\cdot f\cdot t)) \qquad V_1(f,n) := -i\cdot\frac{4\cdot Vo}{n\cdot\pi}$$

Solution

$$v_2(t,f) := \sum_{k=1}^{nmax} v_2(t,f,2\cdot k-1)\cdot e^{(2\cdot k-1)\cdot i\cdot 2\cdot\pi\cdot f\cdot t}$$

Frequency

$f := 2314\ Hz$ $\qquad T := \frac{[1..200]-1}{200-1}\cdot\frac{2}{f}+\frac{4}{f}$

Using spice#

```
.TRAN 0 {6/freq} {4/freq} {0.01/freq}
.SAVE V(1) V(2) I(R1)
.PARAM freq=@
```

$\chi M := \text{"}\chi M\text{"}$

$CR := \text{num2str}(\text{str2num}(\text{concat}(\text{"\textbackslash"}, \text{"000D"}, \text{"\textbackslash"})))$

$wave := \text{"PULSE(-0.8 0.8 0 1u 1u \{1/freq/2-1u\} \{1/freq\})"}$

$circ := \text{strrep}(\text{description}(\chi Ver), \text{"V1s"}, wave)$

$mode := \text{strrep}(\text{description}(\chi M), \text{"@"}, \text{num2str}(\text{eval}(f\ s)))$

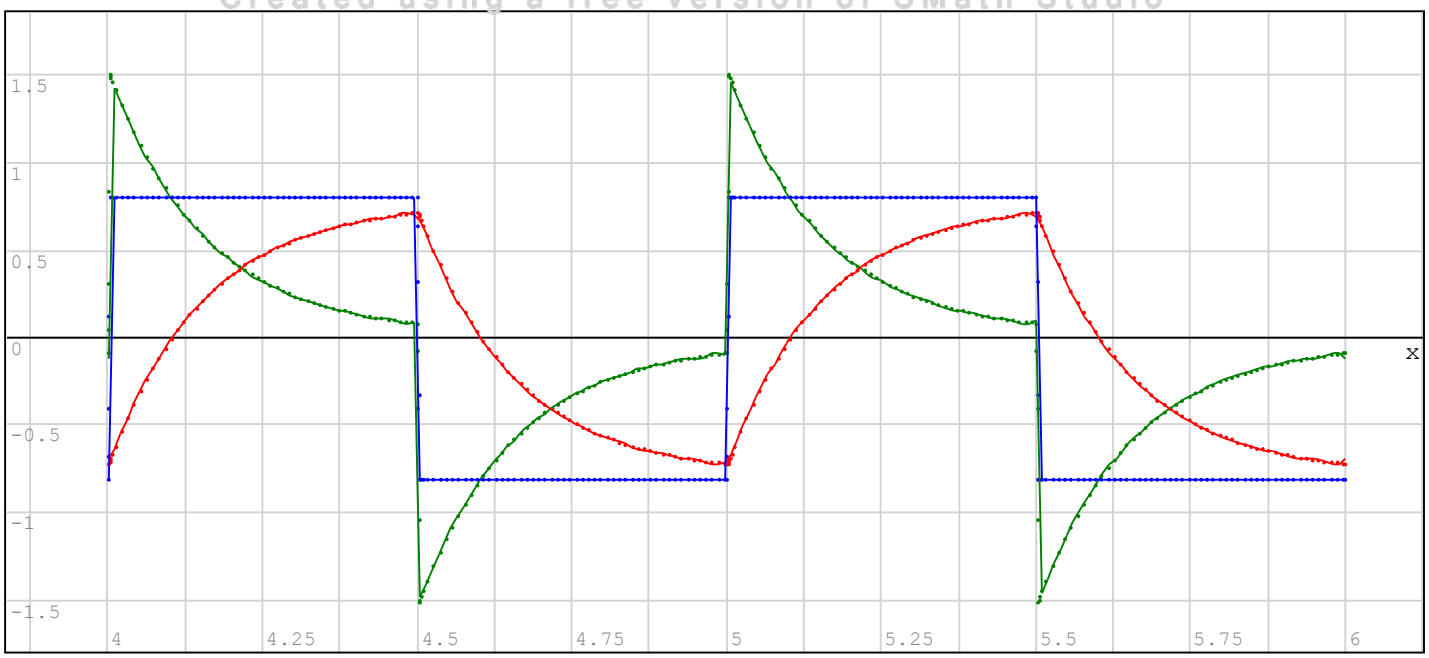
$M :=$  $\text{"\{CR\}\{circ\}\{CR\}\{mode\}\{CR\}.END"}, \_$

$$\begin{bmatrix} T_M & V_1 & V_2 \end{bmatrix} := \begin{bmatrix} \text{col}(M,1)\ s & \text{col}(M,2)\ V & \text{col}(M,3)\ V \end{bmatrix} \qquad \text{rows}(M) = 239$$

```
V1 1 0 V1s
R1 1 2 327.1k
C1 2 0 200p
RT 2 3 9MEG
CT 2 3 12.78p
LK 3 4 250n
RK 4 5 1.5
CK 5 0 100p
RO 5 0 1MEG
CO 5 0 15p
```

$\chi Ver := \text{"}\chi Ver\text{"}$

Compare both solutions



$$\begin{cases} \text{augment}\left(T\cdot f,\ V1_n := \text{eval}\left(\overrightarrow{\text{Re}\left(v_1\left(T,f\right)\right)}\right)\right) \\ \text{augment}\left(T\cdot f,\ V2_n := \text{eval}\left(\overrightarrow{\text{Re}\left(v_2\left(T,f\right)\right)}\right)\right) \\ \text{augment}\left(T\cdot f,\ V1_n - V2_n\right) \\ \text{augment}\left(T_M\cdot f,\ V_1,\ ".",\ 6,\ "blue"\right) \\ \text{augment}\left(T_M\cdot f,\ V_2,\ ".",\ 6,\ "red"\right) \\ \text{augment}\left(T_M\cdot f,\ V_1 - V_2,\ ".",\ 6,\ "green"\right) \end{cases}$$

Alvaro

$\text{appVersion}\left(4\right) = \text{"1.73.9126.0"}$