Half-Wave Rectifier

Generated by SMCSim

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Simulation of ckt/HWRectifierFilter.ckt

Circuit Diagram:

NetList:

** Half-Wave Rectifier*
V1 1 0 sine (5 50)
D1 1 2 mymodel (1e-8 0.026)
R1 2 0 10000
C1 2 0 10e-3
.tran 0 100 0.5
.plot v(1) v(2)
.end

System of Equations representing the electrical circuit:

$$i_{V_1} + D_{1f}(v_1, v_2) = 0 \tag{1}$$

$$(R_1)v_2 + (C_1)\frac{dv_2}{dt} + -D_{1f}(v_1, v_2) = 0 \tag{2}$$

$$v_1 = V_1 \tag{3}$$

$$D_{nf}(v_a, v_b) = Is_n(1 - e^{(v_a - v_b)/vt_n})$$

where Is_n=reverse saturation current and vt_n=threshold voltage of diode n

Matrix form:

The system of equations $\mathbf{Ax} + \mathbf{D}_f(\widehat{\mathbf{x}}) + \mathbf{C}(d\mathbf{x}/dt) = b$ (Symbolically)
Where $\mathbf{A}$, $\mathbf{D}_f$ and $\mathbf{C}$ represent matrices corresponding to linear, nonlinear and time dependent electrical elements respectively. $\mathbf{b}$ represents the vector corresponding to sources.

$$\mathbf{A} = \begin{bmatrix} 0 & 0 & 1 \\ 0 & \widehat{R}_1 & 0 \\ 1 & 0 & 0 \end{bmatrix} \tag{4}$$

$$\mathbf{b} = \begin{bmatrix} 0 \\ 0 \\ V_1 \end{bmatrix} \tag{5}$$

$$\mathbf{D}_f = \begin{bmatrix} D_{1f} \\ -D_{1f} \\ 0 \end{bmatrix} \tag{6}$$

$$\mathbf{C} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & C_1 & 0 \\ 0 & 0 & 0 \end{bmatrix} \tag{7}$$

$$\mathbf{x} = \begin{bmatrix} v_1 \\ v_2 \\ i_{V_1} \end{bmatrix} \tag{8}$$

$$\widehat{\mathbf{x}} = \begin{bmatrix} (v_1, v_2) \end{bmatrix} \tag{9}$$

Note that the matrix contains $\widehat{R}$ entries (corresponding to resistors) whose values are equal to $1/R$

The number of equations are 3
Unknowns:
Node potentials: 2 Current Variables: 1

Operating Point (DC) Analysis:
All capacitors are open circuited and inductors are short circuited.

System of Equations representing the electrical circuit:

$$i_{V_1} + D_{1f}(v_1, v_2) = 0 \tag{10}$$

$$(R_1)v_2 + -D_{1f}(v_1, v_2) = 0 \tag{11}$$

$$v_1 = V_1 \tag{12}$$

$$D_{nf}(v_a, v_b) = Is_n(1 - e^{(v_a - v_b)/vt_n})$$

where Is_n=reverse saturation current and vt_n=threshold voltage of diode n

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Application of Newton-Raphson method:
Nonliner models:

See linearized model for diode D_1 in diode_D1.eps

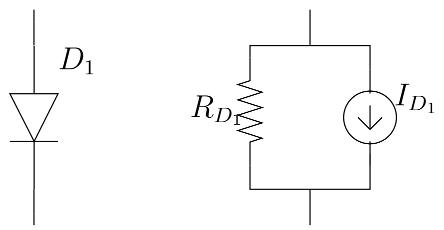

Figure 1: linearization of diode D_1

System of Equations representing the electrical circuit:

$$(R_{D_1})v_1 + (-R_{D_1})v_2 + i_{V_1} = -i_{D_1} \tag{13}$$

$$(R_{D_1})v_1 + (R_{D_1} + R_1)v_2 = i_{D_1} \tag{14}$$

$$v_1 = V_1 \tag{15}$$

Transient Analysis:

Results:

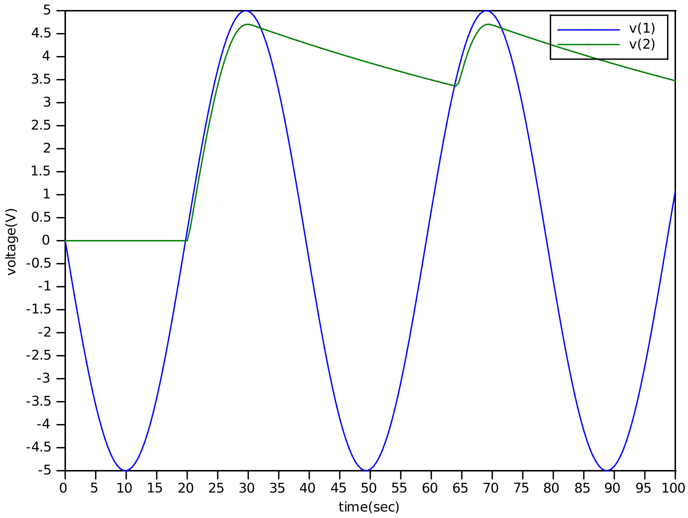

Figure 2: plot