

ENEE610 HW1

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1.

(a)(b) total number of nodes

$N=1, n_1 = 3$

$N=2, n_2 = 6$

$N=3, n_3 = 10$

$N=4, n_4 = 15 \Rightarrow n_N = 1+2+3+\dots+(N+1) = \frac{(N+2)}{2} \times (N+1)$

$= \frac{(N+1)(N+2)}{2}$

total number of branches

$N=1, b_1 = 3$

$N=2, b_2 = 3+6 = 9$

$N=3, b_3 = 3+6+9 = 18$

$N=4, b_4 = 3+6+9+12 = 30$

$\Rightarrow b_N = 3(1+2+3+4+\dots+N) = \frac{3N(N+1)}{2}$

total number of tree branches (tree  $\rightarrow$  all nodes but no loops)

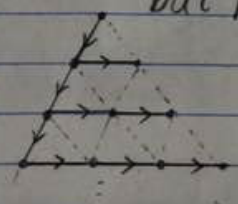
$N=1, t_1 = 2 = n_1 - 1$

$N=2, t_2 = 5 = n_2 - 1$

$N=3, t_3 = 9 = n_3 - 1$

$N=4, t_4 = 14 = n_4 - 1$

$\Rightarrow t_N = n_N - 1 = \frac{(N+1)(N+2)}{2} - 1 = \frac{N(N+3)}{2}$



total number of link branches

$N=1, l_1 = 1 = b_1 - t_1$

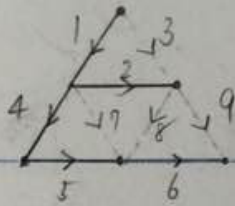
$N=2, l_2 = 1+3 = 4 = b_2 - t_2$

$N=3, l_3 = 1+3+5 = 9 = b_3 - t_3$

$N=4, l_4 = 1+3+5+7 = 16 = b_4 - t_4$

$\Rightarrow l_N = b_N - t_N = 1+3+5+\dots+(2N-1) = N^2$

(c) for  $N=2$ ,



KCL

$$0 = i_1 + i_3$$

$$0 = i_2 + i_3 - i_8 - i_9$$

$$i_4 = i_5$$

$$0 = i_5 + i_7 + i_8 + i_9$$

$$0 = i_6 + i_9$$

cut set e

1	0	0	0	0	1	0	0	0	} $i_t$	=	0								
0	1	0	0	0	1	0	-1	-1				} $i_k$	0						
0	0	1	0	0	0	1	1	1						} $i_k$	0				
0	0	0	1	0	0	1	1	1								} $i_k$	0		
0	0	0	0	1	0	0	0	1										} $i_k$	0
<u><u><math>I_t</math></u></u>					<u><u><math>K</math></u></u>														

KVL

$$0 = v_3 - v_1 - v_2$$

$$0 = v_7 - v_4 - v_5$$

$$0 = v_8 + v_2 - v_4 - v_5$$

$$0 = v_9 + v_2 - v_4 - v_5 - v_6$$

tie set j

-1	-1	0	0	0	1	0	0	0	} $v_t$	=	0								
0	0	-1	-1	0	0	1	0	0				} $v_t$	0						
0	1	-1	-1	0	0	0	1	0						} $v_t$	0				
0	1	-1	-1	-1	0	0	0	1								} $v_t$	0		
<u><u><math>-K^T</math></u></u>					<u><u><math>I_e</math></u></u>													} $v_t$	0

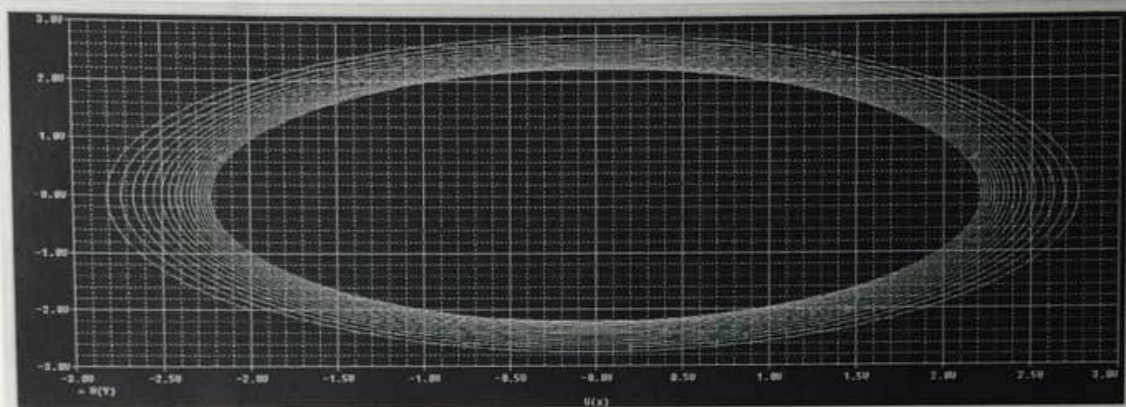
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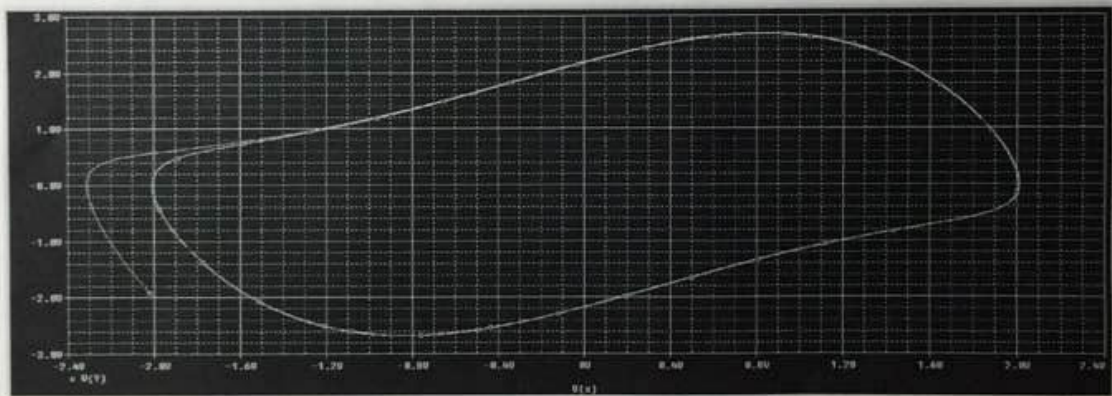
2. (a)

(i) Initial Condition:  $x(0) = y(0) = 2$

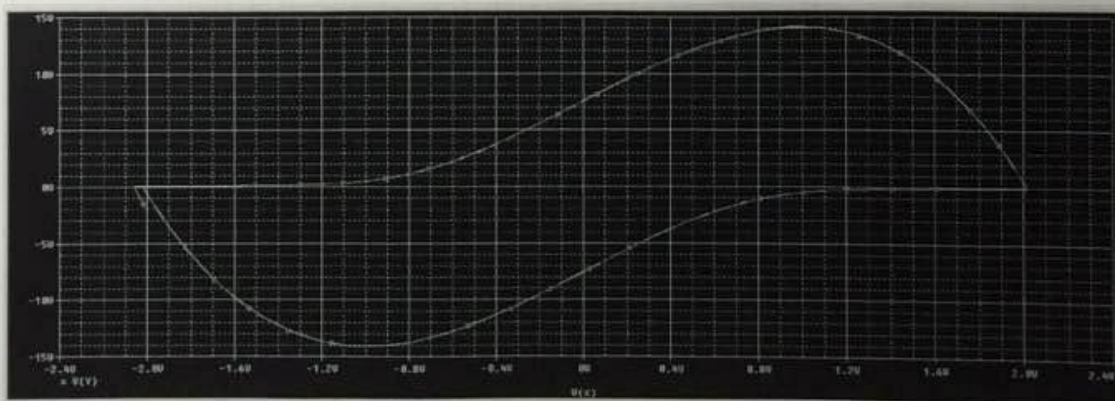
$\varepsilon = 0.01$



$\varepsilon = 1$



$\varepsilon = 10$



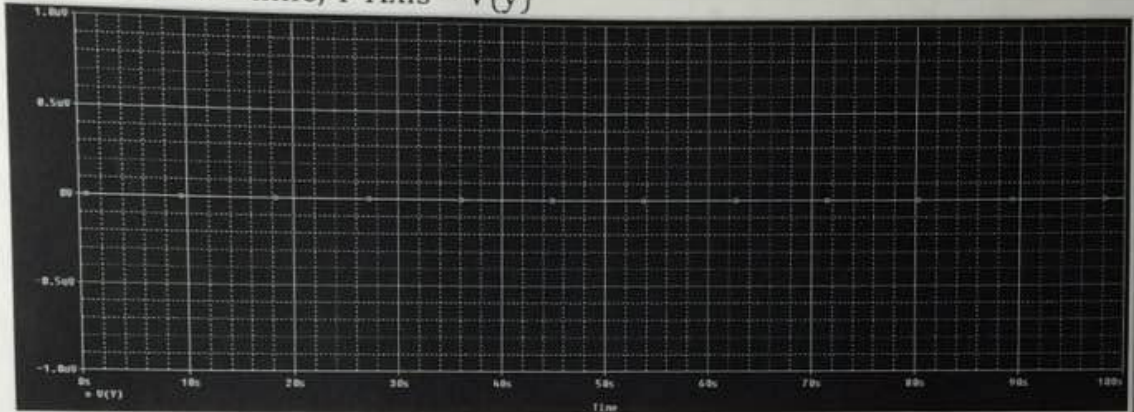
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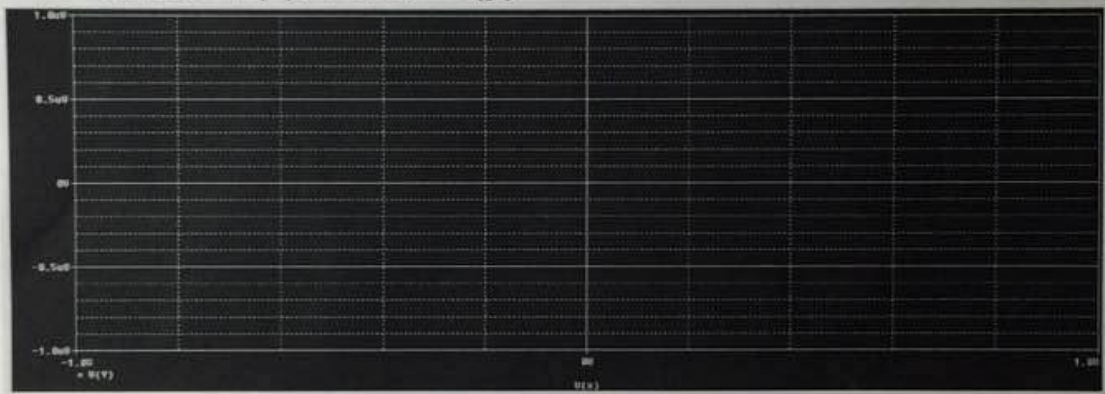
(ii) Initial Condition:  $x(0) = y(0) = 0$

The plots are basically the same for  $\epsilon = 0.01, 1, 10$ :

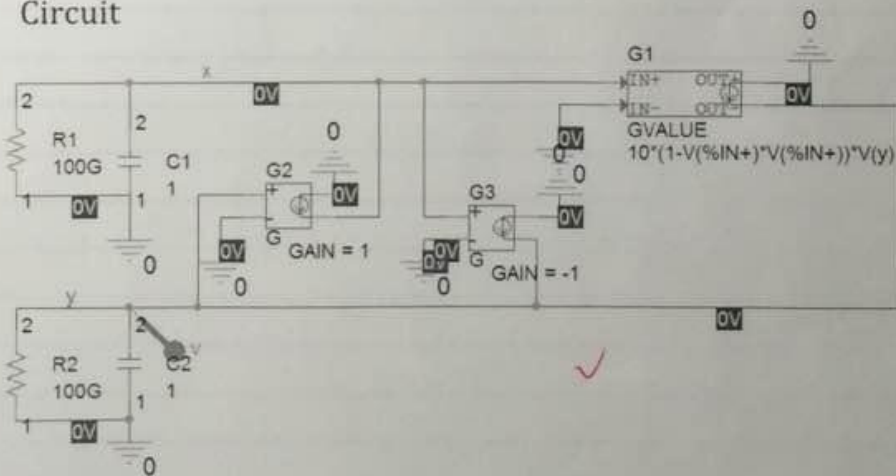
X-Axis = time, Y-Axis =  $V(y)$



X-Axis =  $V(x)$ , Y-Axis =  $V(y)$

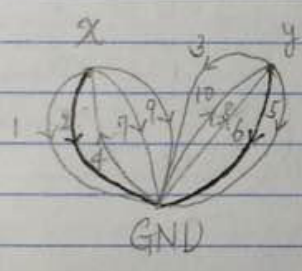
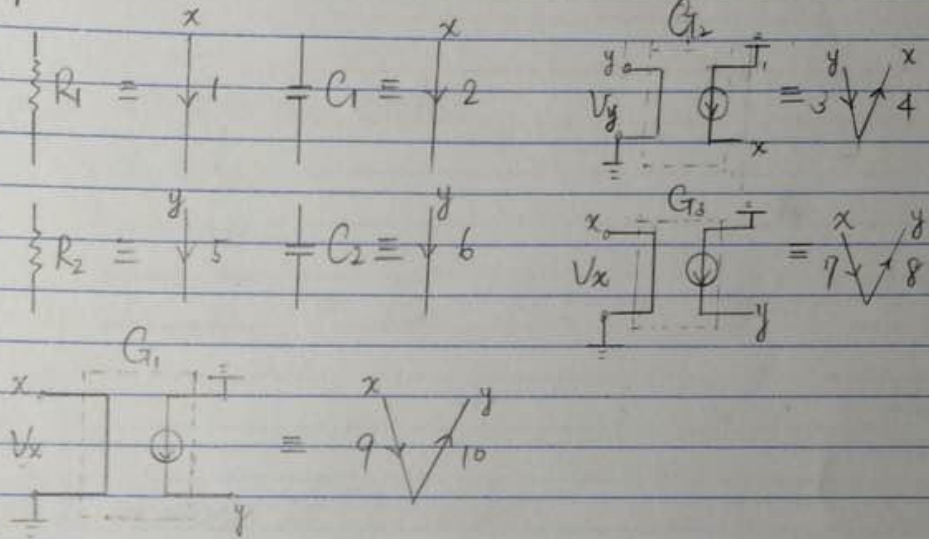


2. (b)  
Circuit



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graph:



✓ tree branches: 2, 6  
(capacitors)  $C_1$ ,  $C_2$