EE213 Homework-2 KAHALIKA PODDAR

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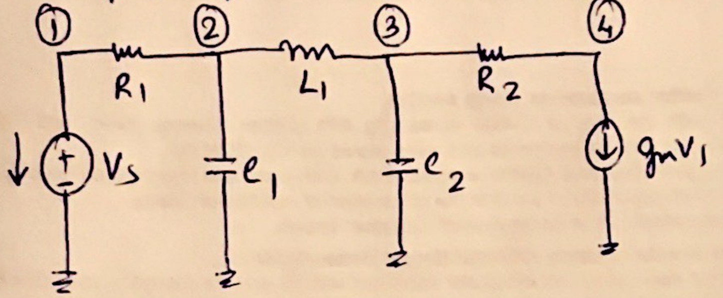
1.a) MNA in frequency domain



	1	2	3	4	i_S	i_{L_1}	RHS
1	$\frac{1}{R_1}$	$-\frac{1}{R_1}$	0	0	-1	0	0
2	$-\frac{1}{R_1}$	$\frac{1}{R_1}+sC_1$	0	0	0	1	0
3	0	0	$sC_2+\frac{1}{R_2}$	$-\frac{1}{R_2}$	0	-1	0
4	g_m	0	$-\frac{1}{R_2}$	$\frac{1}{R_2}$	0	0	0
branch i_S	1	0	0	0	0	0	V_S
branch i_L	0	1	-1	0	0	$-sL_1$	0

P.T.O →

1.b MNA in time domain

	1	2	3	4	i_s	i_{L_1}	R.H.S
1	$1/R_1$	$-\frac{1}{R_1}$	0	0	-1	0	0
2	$-\frac{1}{R_1}$	$\frac{1}{R_1}+\frac{C}{h}$	0	0	0	1	$\frac{C_1}{h}[V_2(t-h)]$
3	0	0	$\frac{C}{h}+\frac{1}{R_2}$	$-\frac{1}{R_2}$	0	-1	$\frac{C_2}{h}[V_3(t-h)]$
4	g_m	0	$-\frac{1}{R_2}$	$\frac{1}{R_2}$	0	0	0
branch i_s	1	0	0	0	0	0	V_s
branch i_2	0	1	-1	0	0	$-\frac{L_1}{h}$	$-\frac{L_1}{h}[i_L(t-h)]$

1.c $Gx + C\frac{dx}{dt} = Bu$

	1	2	3	4	$i_s(5)$	$i_2(6)$
1	$1/R_1$	$-\frac{1}{R_1}$	0	0	-1	0
2	$-\frac{1}{R_1}$	$\frac{1}{R_1}$	0	0	0	1
3	0	0	$\frac{1}{R_2}$	$-\frac{1}{R_2}$	0	-1
4	g_m	0	$-\frac{1}{R_2}$	$\frac{1}{R_2}$	0	0
$i_s(5)$	1	0	0	0	0	0
$i_2(6)$	0	1	-1	0	0	0

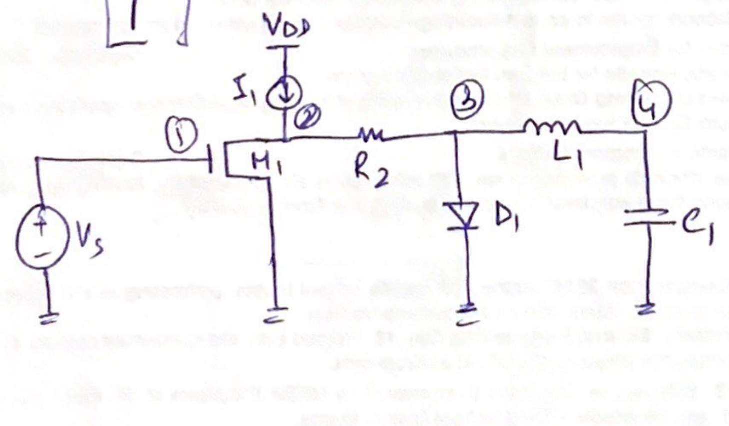
$= G$

1.e

$$
C = \begin{array}{c|cccccc}
 & 1 & 2 & 3 & 4 & 5 & 6 \\
\hline
1 & 0 & 0 & 0 & 0 & 0 & 0 \\
2 & 0 & C_1 & 0 & 0 & 0 & 0 \\
3 & 0 & 0 & C_2 & 0 & 0 & 0 \\
4 & 0 & 0 & 0 & 0 & 0 & 0 \\
5 & 0 & 0 & 0 & 0 & 0 & 0 \\
6 & 0 & 0 & 0 & 0 & 0 & -L_1
\end{array}
$$

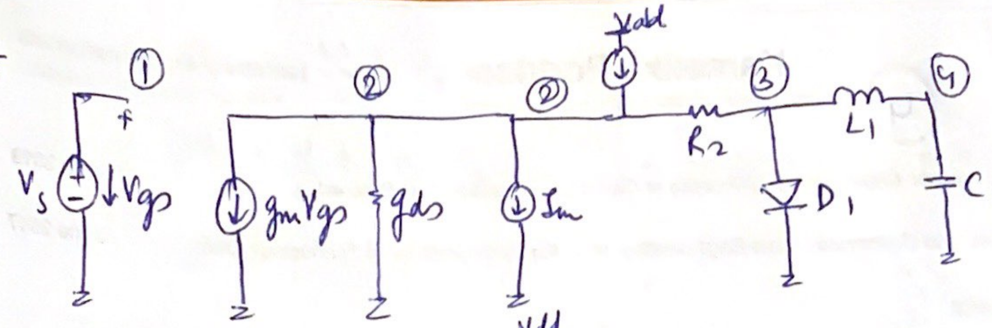
$$
B = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}
\qquad
u = \begin{bmatrix} V_s \end{bmatrix}_{1\times 1}
$$

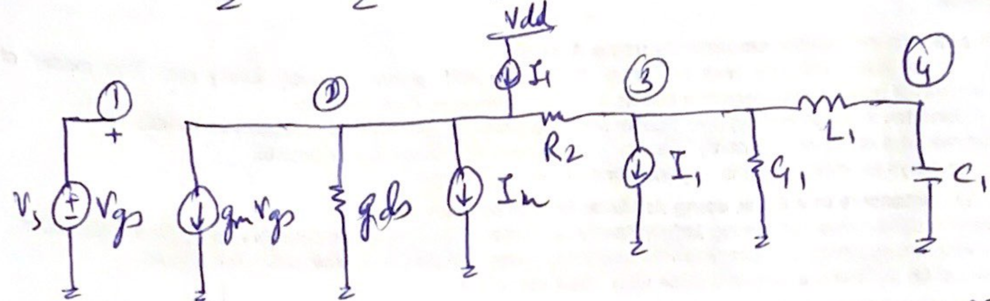
2.a



P.T.O →

2.a





$$g_m = \frac{W}{L} k . V_2 \quad , \quad g_{ds} = \frac{W}{L} k \left[V_s - V_t - V_2^{(k)} \right]$$

$$I_m = \frac{W}{L} k \left[(V_s - V_t) V_2^{(k)} - \frac{1}{2} \left(V_2^{(k)} \right)^2 \right] - \frac{W}{L} k V_2^{(k)} . V_s$$

$$- \frac{W}{L} k \left(V_s - V_t - V_2^{(k)} \right) . V_2^{(k)}$$

$$G_1^{(k)} = \alpha e^{\alpha V_D} \quad , \quad i_0^{(k)} = i_D^{(k)} - \alpha e^{\alpha V_D^{(k)}} . V_D^{(k)}$$

$$i_D = e^{\alpha V_D} - 1$$

	1	2	3	4	i_s	i_{L_1}	RHS
1	0	0	0	0	1	0	0
2	$g_m^{(k)}$	$g_{ds}^{(k)} + \frac{1}{R_2}$	$-\frac{1}{R_2}$	0	0	0	$-I_n^{(k)} + I_1$
3	0	$-\frac{1}{R_2}$	$\frac{1}{R_2} + G_1^{(k)}$	0	0	1	$-i_{0,1}^{(k)}$
4	0	0	0	$\frac{C_1}{h}$	0	-1	$\frac{C_1}{h}[V_4(t-h)]$
~~5~~							
branch i_s	1	0	0	0	0	0	V_s
branch i_L	0	0	1	-1	0	$-\frac{L_1}{h}$	0

2.b

Transistor

$$g_m = \frac{W}{L} k . V_2 = 1$$

$$g_{ds} = \frac{W}{L} k \left[V_S - V_t - V_2^{(k)} \right] = 1[2 - 0.5 - 1] = 0.5$$

$$I_m = 1\left[(2-0.5)\,1^{(1)} - \frac{1}{2}(1)^2\right] - 2.\,1^{(1)}(1) - 1\left(2 - 0.5 - 1^{(1)}\right).1$$

$$= -1.5$$

Diode

$$g_1^{(k)} = \alpha e^{\alpha V_D} = 10 e^{10 \times 0} = 10$$

$$i_{0,1}^{(k)} = i_D^{(1)} - \alpha e^{\alpha V_3(k)} V_3^{(k)} = 0$$

	1	2	3	4	i_s	i_2	R.H.S
1	0	0	0	0	1	0	0
2	1	1.5	-1	0	0	0	1.5+1=2.5
3	0	-1	1+10=11	0	0	1	0
4	0	0	0	1	0	-1	0
branch i_1	1	0	0	0	0	0	2
branch i_2	0	0	1	-1	0	-1	0

$V_1 = 2$, ~~V_2~~

$V_2 = 0.354$

$V_3 = 0.031$

$V_4 = 0.015$

$i_S = 0.000$

$i_2 = 0.015$

3.

Forward Euler

$$y(t_n) = y(t_{n-1}) + h.f(y(t_{n-1}))$$

Equation $= x' = -x + t$

$x(0) = 1$ time step $= 0.1$

$$x_1 = x_0 + 0.1 f(x_0)$$
$$= 1 + 0.1(-1+0)$$
$$\boxed{x_1 = 0.9}$$

$$x_2 = x_1 + 0.1 f(x_1)$$
$$= 0.9 + 0.1(-0.9+1)$$
$$\boxed{x_2 = 0.91}$$

Backward Euler

$$y(t_n) = y(t_{n-1}) + h.f(y(t_n))$$
$$x_1 = x_0 + h.f(x_1)$$
$$= 1 + 0.1(-x_1+1)$$
$$\boxed{x_1 = 1}$$

$$x_2 = x_1 + h.f(x_2)$$
$$= 1 + 0.1(-x_2+2)$$
$$\boxed{x_2 = 1.09090}$$

P.T.O →

3 Trapezoidal Euler

$$y(t_n) = y(t_{n-1}) + \frac{h}{2}\left[f(y(t_n)) + f(y(t_{n-1})\right]$$

$$x_1 = x_0 + \frac{0.1}{2}\left(-x_1 + 1 - x_0 + 0\right)$$

$$= 1 + \frac{0.1}{2}\left(-x_1 + 1 - 1 + 0\right)$$

$$= \frac{1}{1.05} = 0.952$$

$$x_2 = x_1 + \frac{0.1}{2}\left[x_2 + 2 - 0.952 + 1\right]$$

$$= 0.952 - \frac{0.1}{2}\left(x_2 + 2.048\right)$$

$$= \frac{1.0547}{1.05} = 1.00447$$