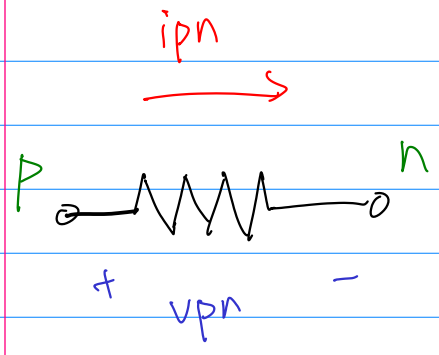


2 terminals : p, n (ref)

branch : pn

I/Os : v_{pn} i_{pn}

use v_{pn}, R

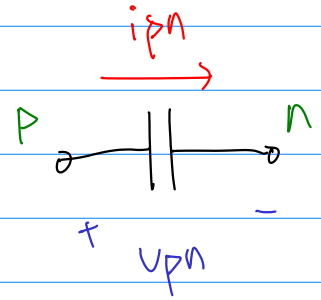
$$i_{pn} = \frac{v_{pn}}{R}$$

explicit out i_{pn}

parameter : R

$$i_{pn} = \frac{d}{dt}(q_e) + f_e$$

$$i_{pn} = \frac{d}{dt}(0) + \frac{v_{pn}}{R}$$



2 terminals : p, n (ref)

branch : pn

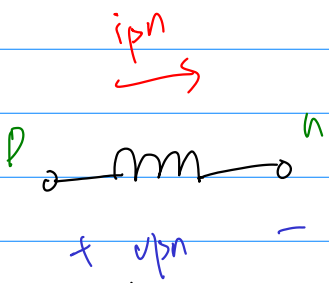
I/Os : v_{pn} i_{pn}

$$i_{pn} = \frac{d}{dt}(C \cdot v_{pn}) + 0$$

($C \cdot v_{pn}$: q_e, 0 : f_e)

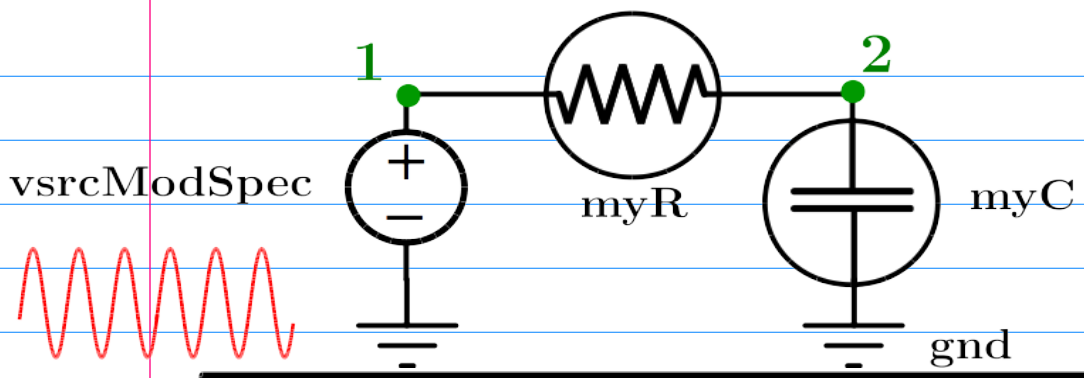
explicit out : i_{pn}

parameter : C

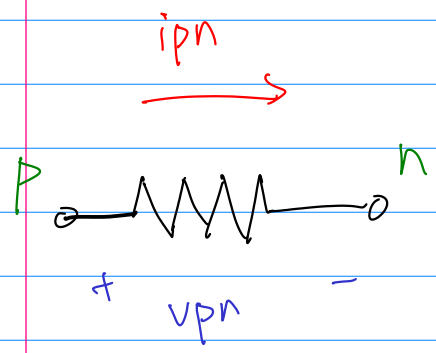


$$v_{pn} = \frac{d}{dt}(L \cdot i_{pn})$$

explicit v_{pn}




```
1 function cktnetlist = myRC_ckt()
2     cktnetlist.cktname = 'myRC_ckt';
3     cktnetlist.nodenames = {'1', '2'}; % non-ground nodes
4     cktnetlist.groundnodename = 'gnd';
5
6     cktnetlist = add_element(cktnetlist, myR(), 'R1', {'1', '2'}, {{'R', 1000}});
7     cktnetlist = add_element(cktnetlist, myC(), 'C1', {'2', 'gnd'}, 1e-6);
8
9     mysinfunc = @(t, args) sin(2*pi*1000*t);
10
11    cktnetlist = add_element(cktnetlist, vsrcModSpec(), 'V1', ...
12       {'1', 'gnd'}, {}, {{'DC', 1}, {'AC', 1}, {'TRAN', mysinfunc, []}});
13 end % myRC_ckt
```



2 terminals : p, n (ref)

branch : pn

I/Os : v_{pn} i_{pn}

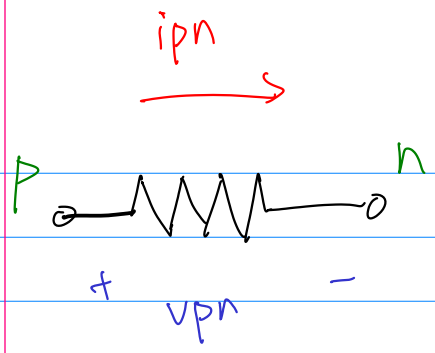
$i_{pn} = \frac{v_{pn}}{R}$

$v_{pn} = R \cdot i_{pn}$

explicit out i_{pn}

parameter R

$0 = v_{pn} - R \cdot i_{pn}$



2 terminals : p, n (ref)

branch : pn

I/Os : vpn ipn

implicit equation: $0 = v_{pn} - R \cdot i_{pn}$

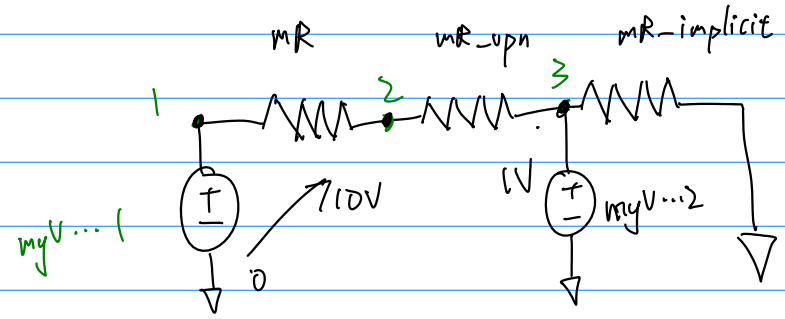
$0 = \frac{d}{dt}(q_i) + f_i$

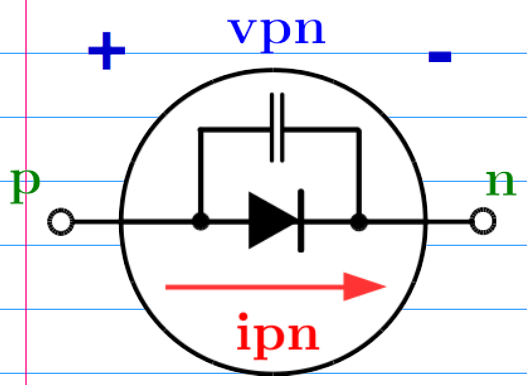
$0 = \frac{d}{dt}(0) + (v_{pn} - R \cdot i_{pn})$

explicit out : none

parameter : R

$$0 = R\left(i_{pn} - \frac{d}{dt}(C \cdot v_{pn})\right) - v_{pn}$$





2 terminals : p · n (ref)

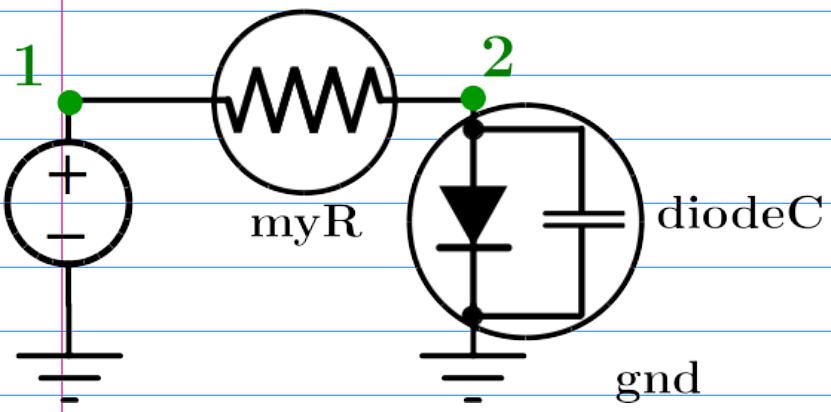
branch : pn

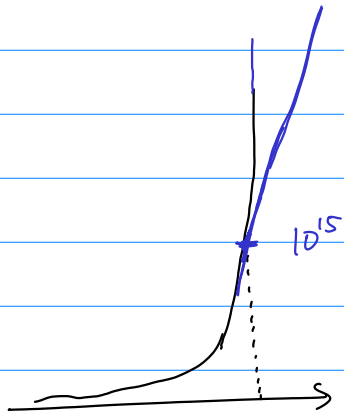
I/Os : v_{pn} i_{pn}

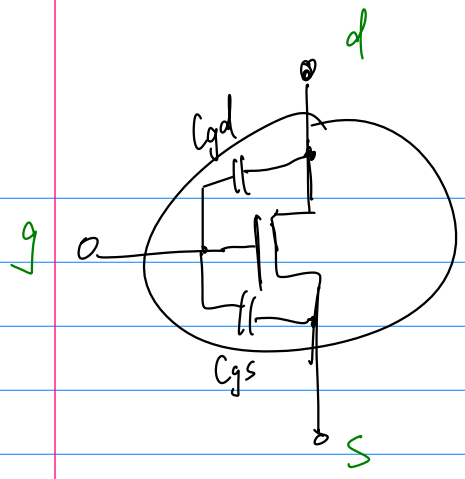
$$i_{pn} = \underbrace{I_s \cdot \left(e^{v_{pn}/V_t} - 1\right)}_{fe} + \frac{d}{dt}\underbrace{\left(C \cdot v_{pn}\right)}_{qe}$$

explicit out : ipn

parameter : I_s , V_t , C





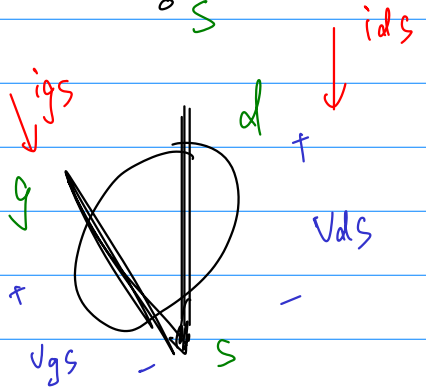


3 terminal : d g s

2 branches : ds , gs

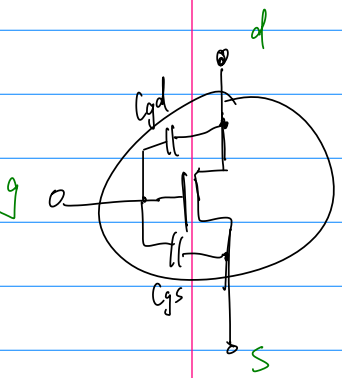
I/Os : ids igs

vds vgs



$$\text{ids\_fe} = \begin{cases} 0 & \text{if } \text{vgs} \le V_{th} \\ \beta\left[(\text{vgs} - V_{th}) - \frac{\text{vds}}{2}\right]\text{vds}, & \text{if } \text{vgs} > V_{th} \text{ and } \text{vgs} < \text{vds} + V_{th} \\ \frac{1}{2}\cdot\beta\cdot(\text{vgs} - V_{th})^2, & \text{if } \text{vds} \ge \text{vgs} - V_{th} \end{cases}$$

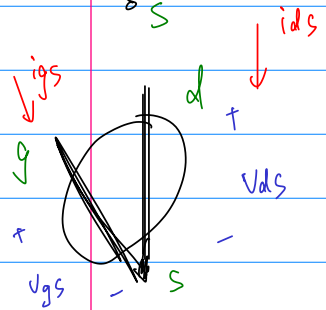
$$\text{igs\_fe} = 0$$

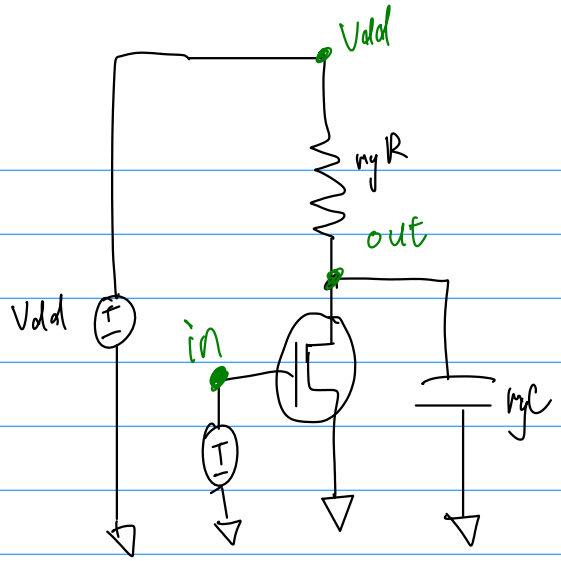


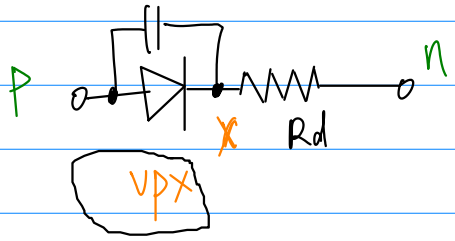
$$\text{ids} = \text{ids\_fe}(\text{vds}, \text{vgs}) + \frac{d}{dt}\left(C_{gd}\cdot(\text{Vds} - \text{Vgs})\right)$$

$$\text{igs} = \underbrace{0}_{\overrightarrow{fe}} + \frac{d}{dt}\underbrace{\left(C_{gs}\cdot\text{vgs} + C_{gd}\cdot(\text{Vgs} - \text{Vds})\right)}_{\overrightarrow{qe}}$$

explicit outputs : $\begin{bmatrix} \text{ids} \\ \text{igs} \end{bmatrix}$







2 terminals : p , n (ref)

branch : pn

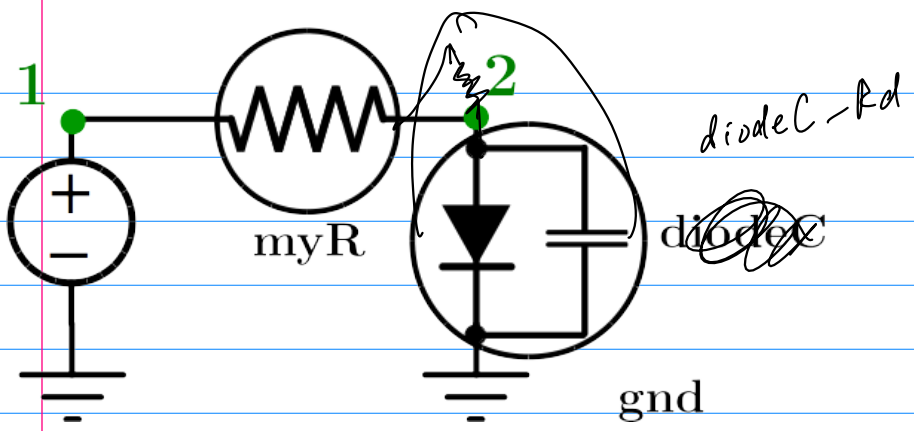
I/Os : v_{pn} i_{pn}

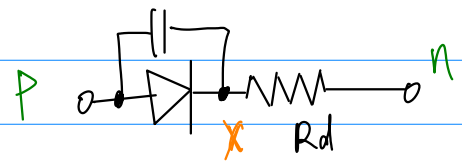
$$i_{pn} = \underbrace{I_s \cdot \left(e^{v_{px}/v_t} - 1\right)}_{f_e} + \underbrace{\frac{d}{dt}\left(C \cdot v_{px}\right)}_{q_e}$$

$$0 = \underbrace{\frac{d}{dt}\left(C \cdot v_{px}\right)}_{-q_i} + \underbrace{I_s \cdot \left(e^{v_{px}/v_t} - 1\right) + \frac{v_{px} - v_{pn}}{R_d}}_{-f_i}$$

explicit out : i_{pn}

parameter : I_s , V_t , C



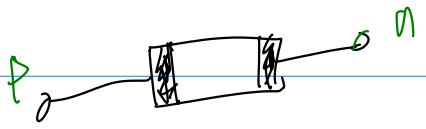


2 terminals : p, n (ref)

branch : pn

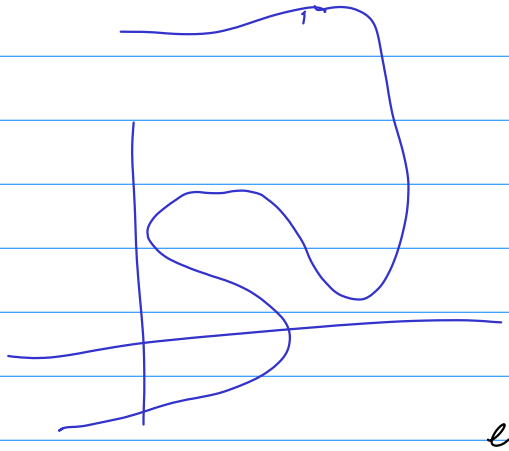
I/Os : v_{pn} i_{pn}

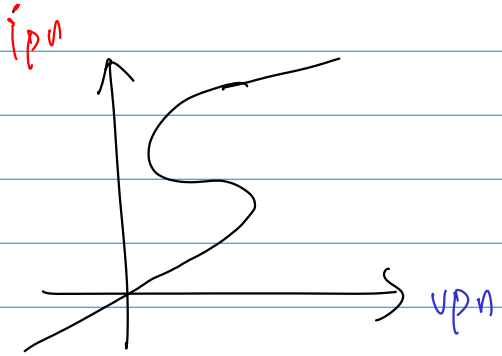
$$0 = \frac{d}{dt}\underbrace{\left(C \cdot v_{pn} - i_{pn} \cdot Rd\right)}_{q_i} + \underbrace{\text{diode}\left(v_{pn} - i_{pn} \cdot Rd\right) - i_{pn}}_{f_i}$$



2 terminals p, n

2 POs : v_{pn} i_{pn}



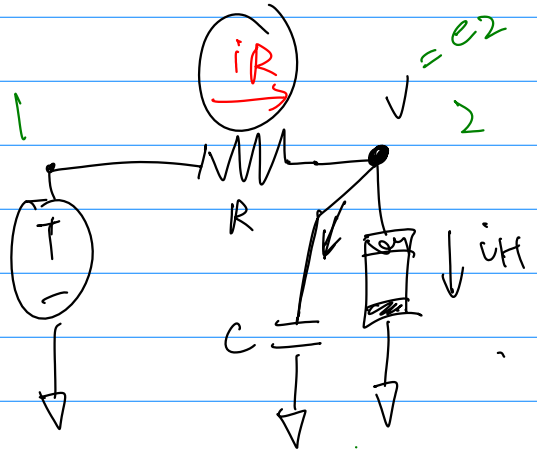


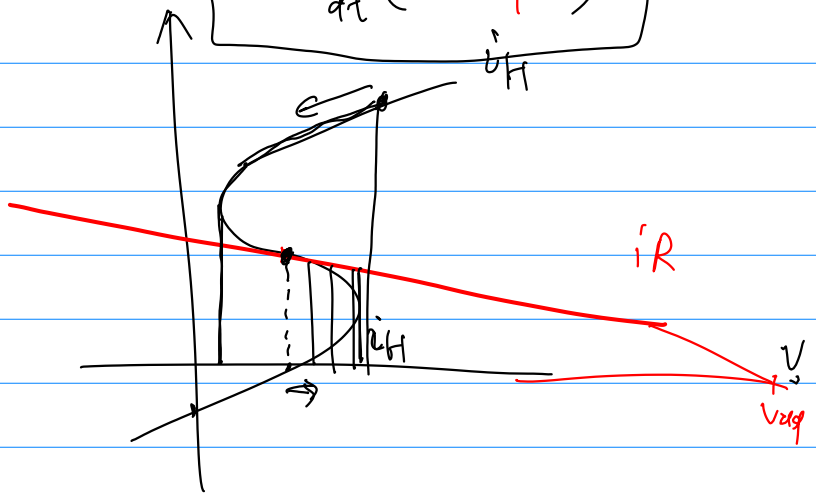
explicit out v_{pn}

$f(v, i) = 0$

$$v_{pn} = A \cdot (i_{pn} - I)^3 + B(i_{pn} - I) + C$$

$$+ \frac{d}{dt}(T \cdot i_{pn})$$





$i_R > i_H$ C charges

v ↑

$i_R < i_H$ C discharges

v ↓