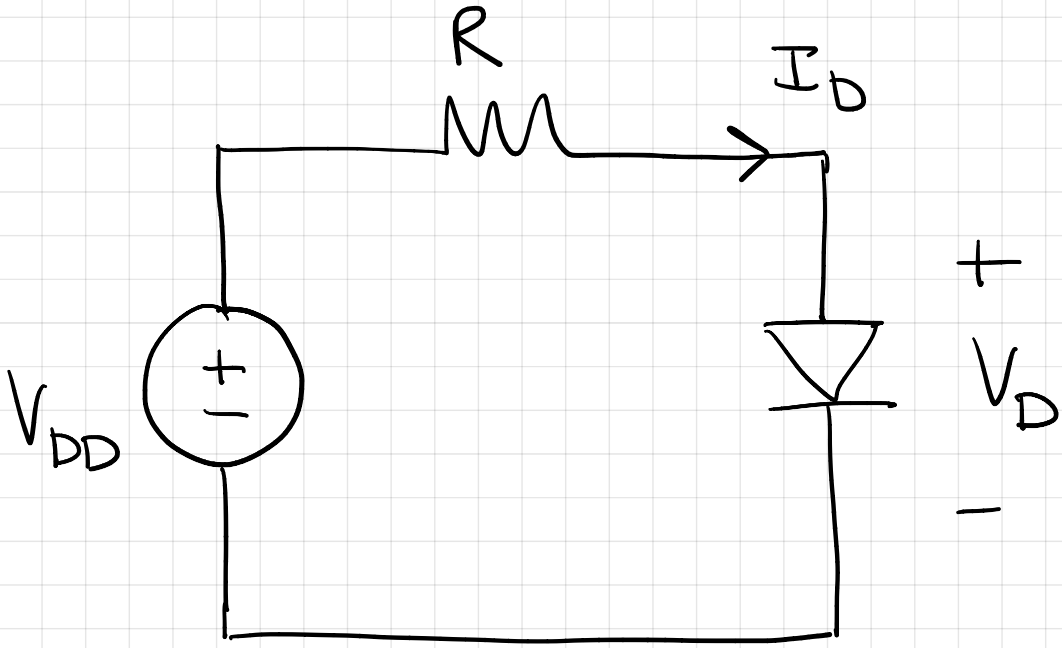
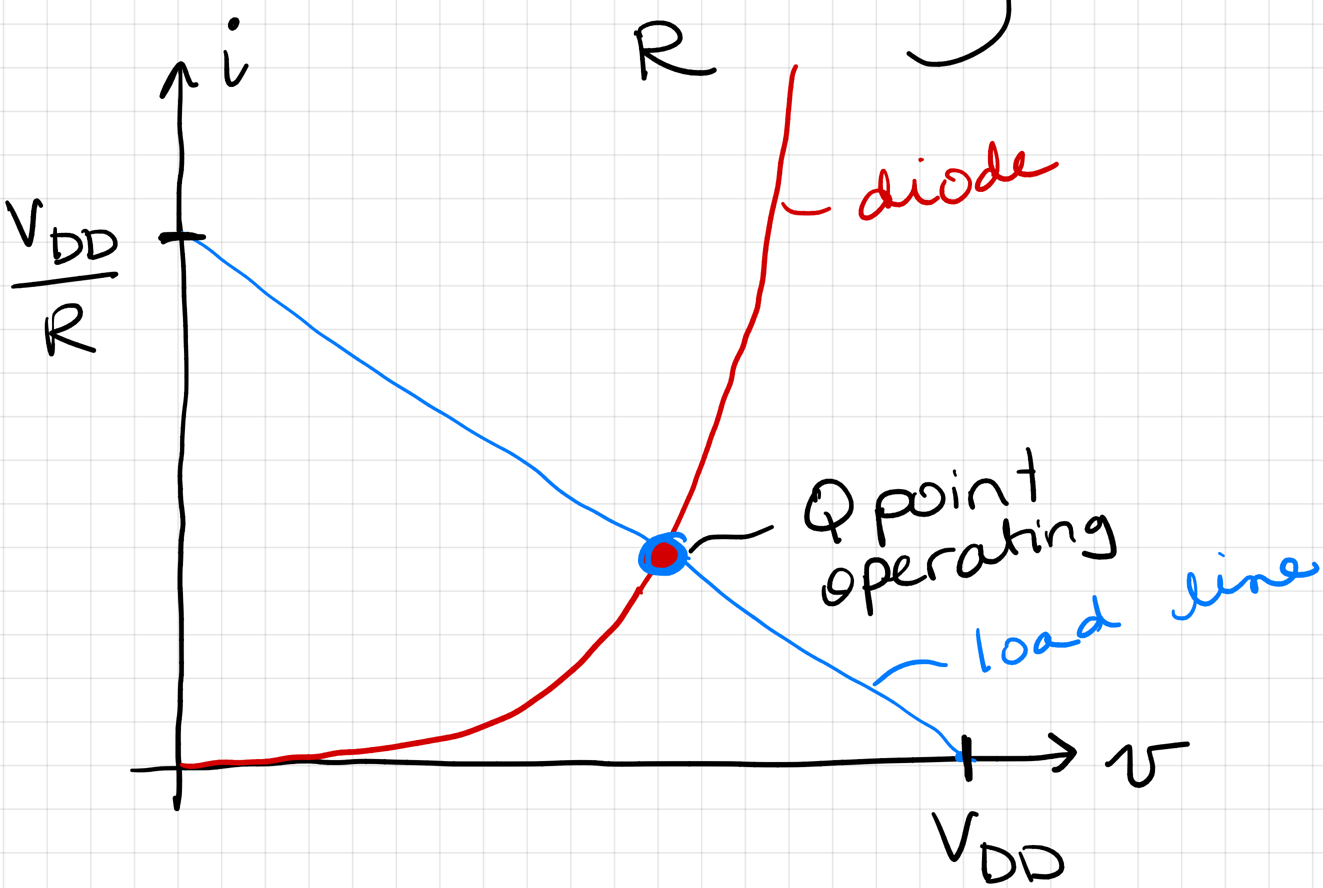
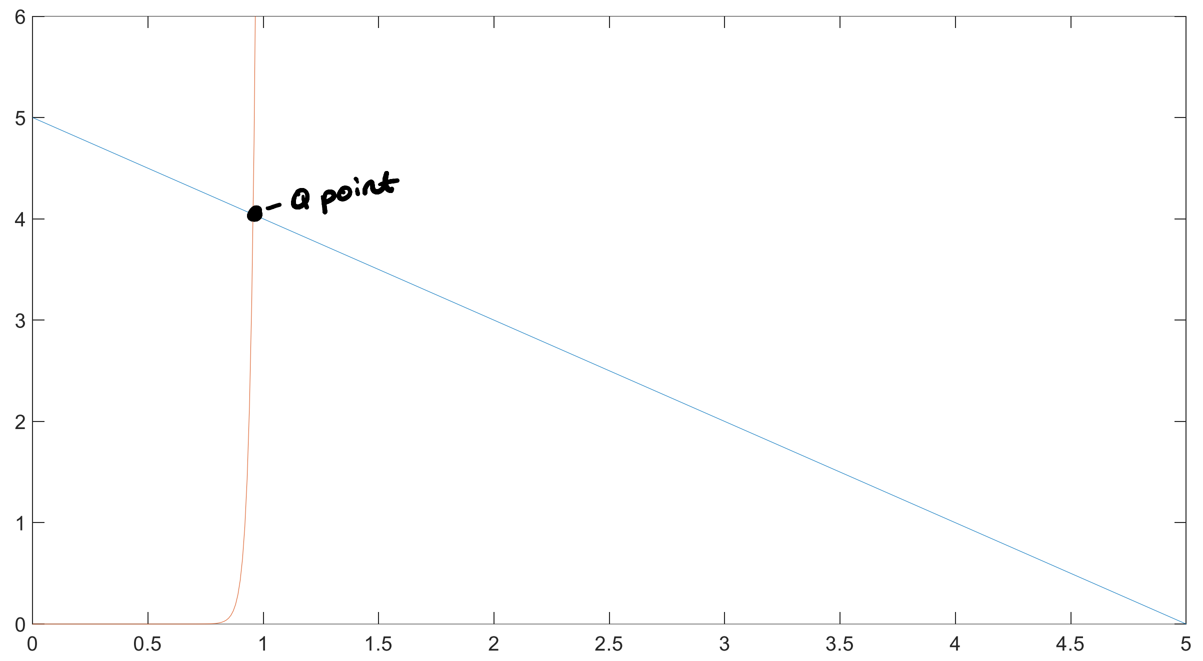


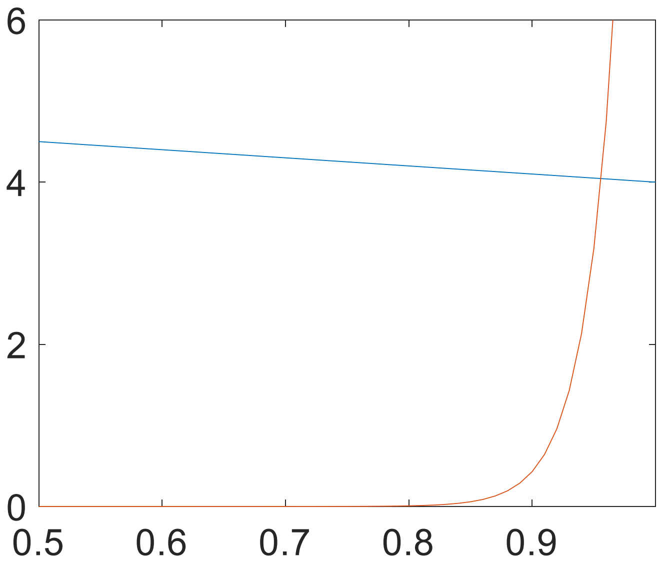
$$I_D = I_S \exp\left(\frac{V_D}{V_T}\right)$$

$$I_D = \frac{V_{DD} - V_D}{R}$$

most accurate model







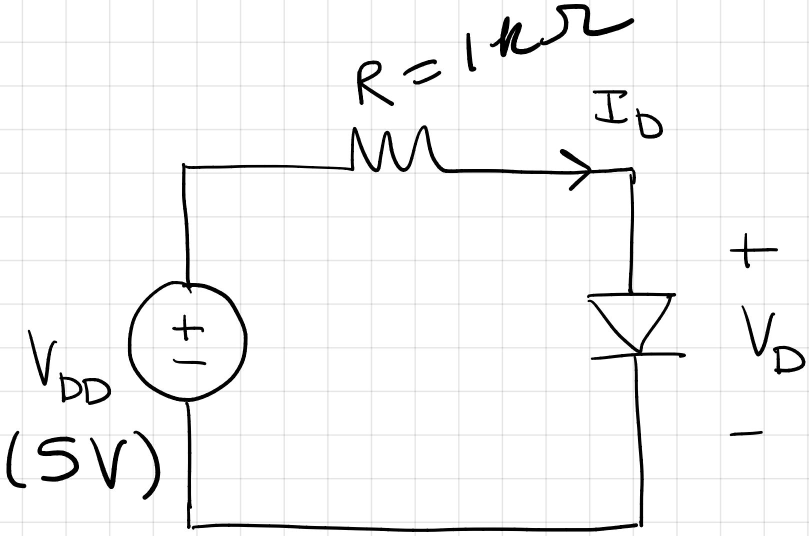
```
%Diode Model
close all
clc

Vdd=5;
R=1; %Resistor is in kohms
Is=1e-16;

Vd1=[0:.1:5];
Vd2=[0:.01:1];
ID1=(Vdd-Vd1)/R;  %currents are in mA
ID2=Is*exp(Vd2/0.025);

plot(Vd1, ID1)
hold on
plot(Vd2, ID2)
```

or, we can iterate



(I_{D1}, V_{D1})

$(1mA, 0.7V)$

$$I_{D2} = \frac{\cancel{V}_{DD}^{\,5} - \cancel{V}_{Di}^{\,.7}}{1} = 4.3mA$$

(I_{D1}, V_{D1})

$(1mA, 0.7V)$

$I_{D2} = 4.3mA$

$V_{D2} = ?$ 0.736V

$$V_{D2} - V_{D1} = V_T \ln\left(\frac{I_{D2}}{I_{D1}}\right)$$

$$V_{D2} = V_{D1} + V_T \ln\left(\frac{I_{D2}}{I_{D1}}\right)$$

$$V_{D2} = 0.7 + (.025) \ln\left(\frac{4.3}{1}\right)$$

$$V_{D2} = 0.736 \text{ V}$$

$$I_{D3} = \frac{5 - V_{D2}}{1} = 4.264\ mA$$

$(I_{D2}, V_{D2}) \Longrightarrow$ $I_{D3} = 4.264 mA$

$4.3mA, .736V$ $V_{D3} =$

$$V_{D3} - V_{D2} = V_T \ln\left(\frac{I_{D3}}{I_{D2}}\right)$$

$$V_{D3} = 0.736\ V$$

Q point

$$(I_{D3}, V_{D3}) = (4.264\ mA, 0.736V)$$

this is not fun

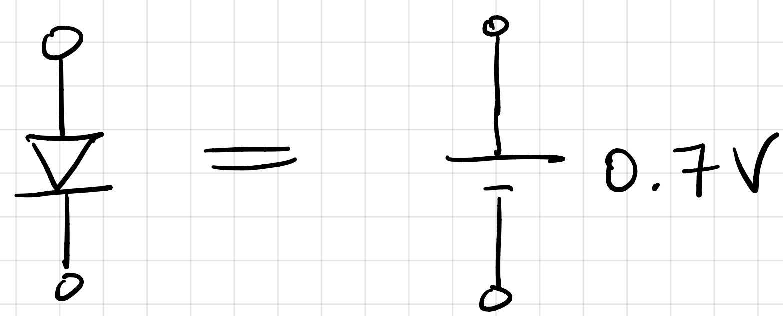
this is time consuming

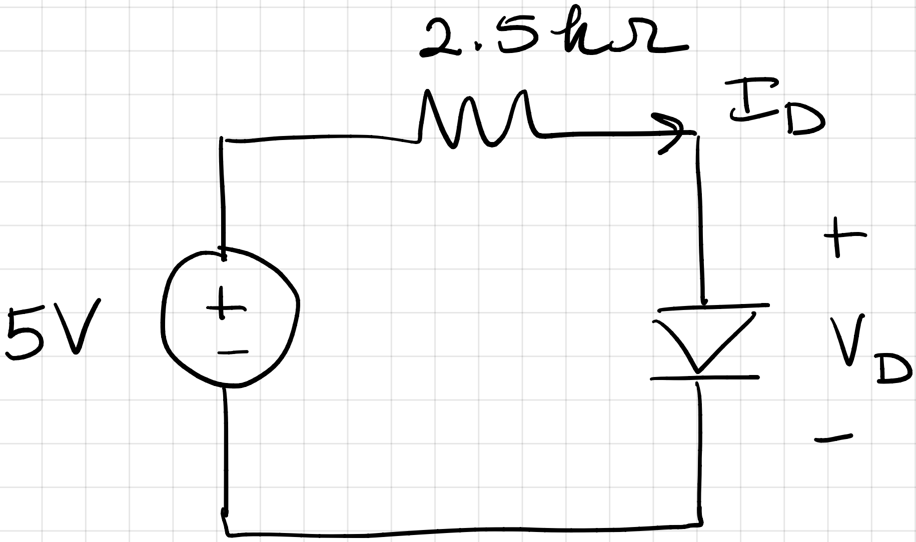
tedious

We need a model that is more accurate than the ideal model but less tedious than the exponential / iterative model.

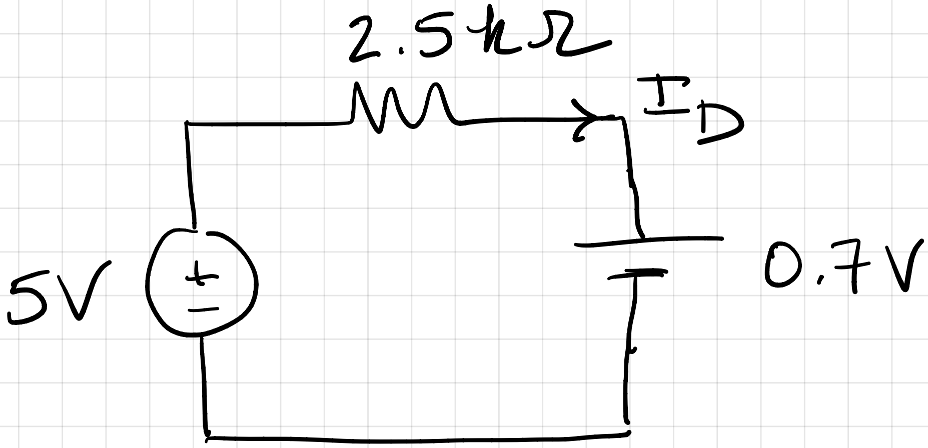
Constant Drop Model

assume that the diode is a battery with a fixed voltage. $V = 0.7\,V$



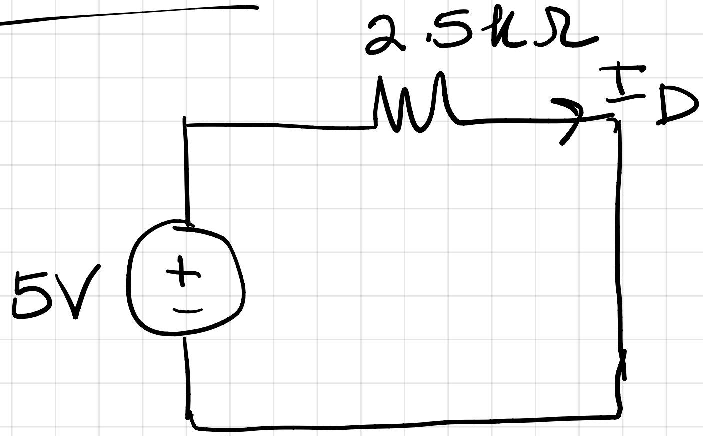


constant drop



$V_D = 0.7V$ $\qquad I_D = \dfrac{5 - 0.7}{2.5k\Omega} = 1.72mA$

ideal model



$V_D = 0$

$I_D = \dfrac{5}{2.5k\Omega} = 2mA$

iterative model

$$I_{D1}, V_{D1} = 1mA, 0.7V$$

$$I_{D2} = \frac{5-0.7}{2.5\times10^3} = 1.72\,mA$$

$$V_{D2} = V_{D1} + V_T \ln\left(\frac{I_{D2}}{I_{D1}}\right)$$

$$V_{D2} = 0.7136\ V$$

$$I_{D3} = \frac{5-V_{D2}}{2.5k\Omega} = 1.715\ mA$$

$$V_{D3} = V_{D2} + V_T \ln\left(\frac{I_{D3}}{I_{D2}}\right)$$

$$V_{D3} = 0.713\ V$$

$$I_{D4} = \frac{5-V_{D3}}{2.5\times10^3} = 1.714\,mA$$

$$V_{D4} = V_{D3} + V_T \ln\left(\frac{I_{D4}}{I_{D3}}\right)$$

$$\boxed{V_{D4} = 0.713\,V}$$

EXP model V_{D4}, I_{D4} = (0.713V, 1.714 mA)

ideal model V_D, I_D = (0, 2mA)

constant drop V_D, I_D = (0.7V, 1.72mA)

% error	V_D	I_D
ideal relative to exp	100%	16.7%
constant drop to exp	1.82%	0.35%