Experiment No : 1

Aim of the Experiment :

To simulate variation of Threshold voltage versus change in channel length under short channel effect using MATLAB Tool.

Theory:

When the channel length is very small, the threshold voltage reduces below the value found using long channel analysis. The Threshold Voltage of a MOSFET under short channel effect is given by the equation

$$(V_{Tn})_{SCE} = V_{FB} + 2|\phi_F| + \frac{1}{C_{ox}}\sqrt{2q\varepsilon_{Si}N_a(2|\phi_F|)}\, f$$

Where

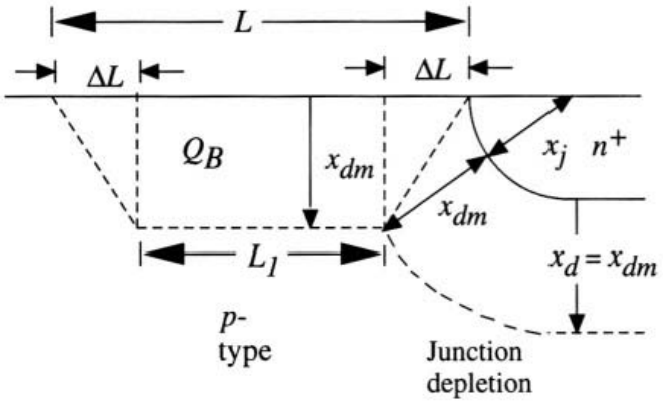
$$2\phi_F = 2\left(\frac{kT}{q}\right)\ln\left(\frac{N_a}{n_i}\right)$$

and

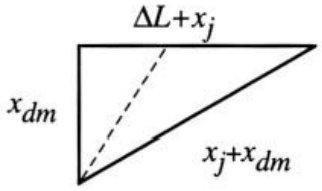
f = (L- ΔL)/L

The value of **ΔL** is obtained from the figure shown below using Pythagorean theorem as :

$$\Delta L = -x_j + \sqrt{x^2{}_j + 2x_j x_{dm}}$$



(a) Details of the geometry



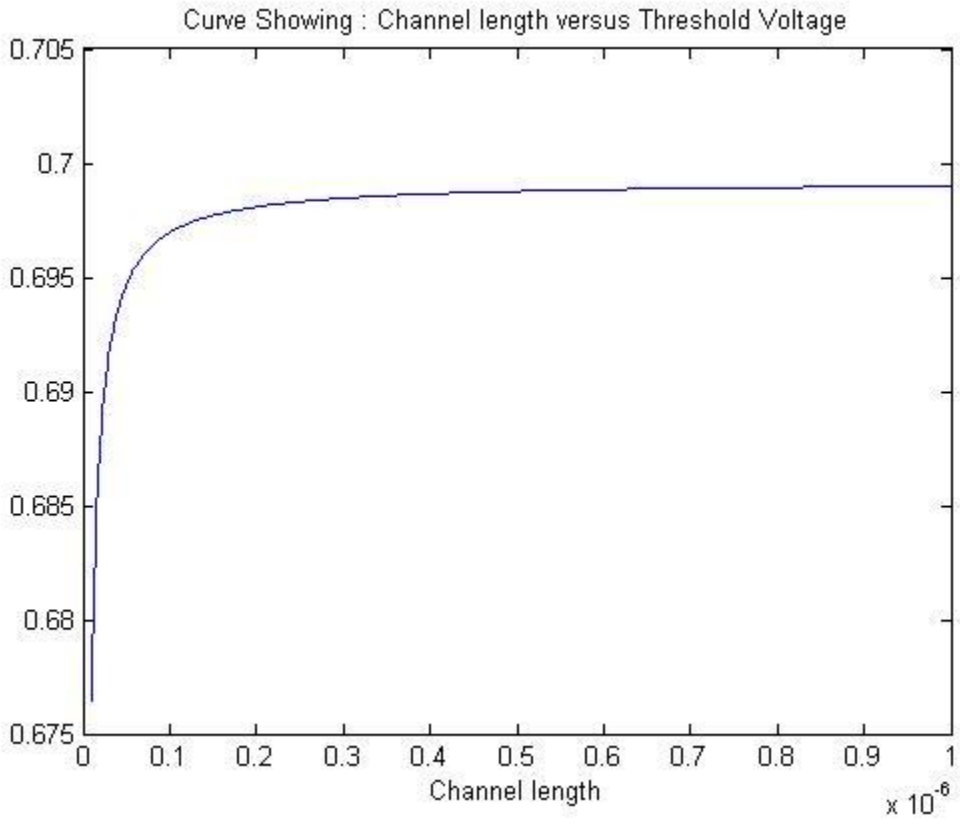
(b) Triangle sides

MATLAB Program to simulate equation for Vth:

```
%Program to plot a curve between channel length and Threshold Voltage
%--------------------------------------------------------------------------------
clear all;
close all;

Ni=1.45*10^10;
Na=10^16;
tox=10^(-9);
eox=3.9*8.854*10^(-14);
Cox=eox/tox;
q=1.6*10^(-19);
a=0.026;
xj=50*10^(-9)
esi=11.2*8.854*10^(-14);
fi=a*log(Na/Ni);
qb=sqrt(4*q*esi*Na*fi);
xdm=sqrt(2*esi*2*fi/(q*Na));
dl=-xj+sqrt(xj^2+(2*xj*xdm));
l=linspace(10^-8,10^-6,1000);
f=(l-dl)./l;
vt=2*fi+qb*f/Cox;
plot(l,vt);
title('Curve Showing : Channel length versus Threshold Voltage');
xlabel('Channel length');
```

Graph Obtained from the MATLAB Program:



Conclusion :

It is observed from the plot that the Threshold Voltage varies exponentially upto certain value of channel length and remains constant there after.

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