Experiment No: - 3

Aim of the Experiment:-

To calculate the variation of mobility of a MOSFET Device with respect to channel length using MATLAB tool.

Theory:-

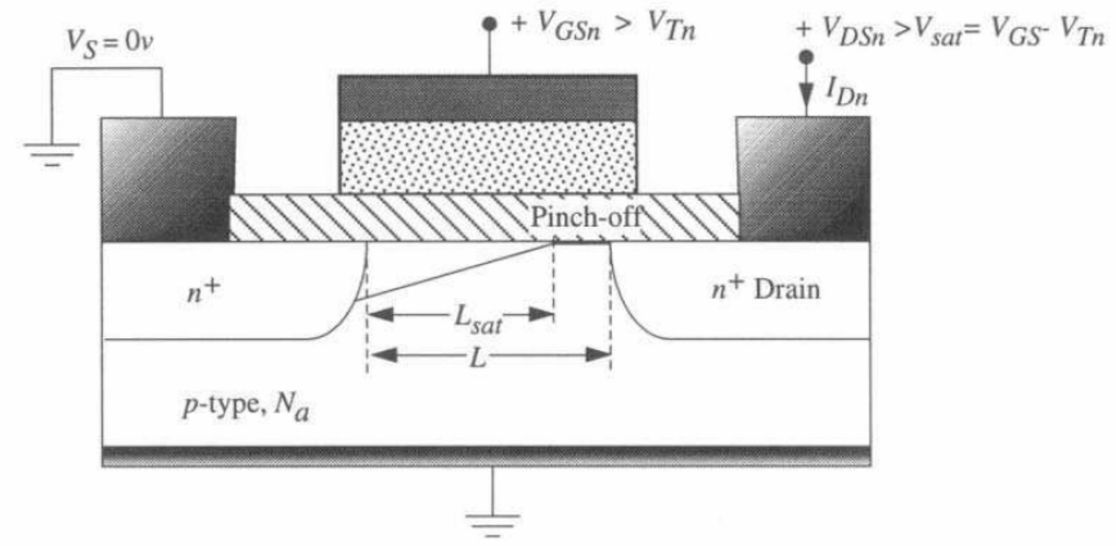
The gradual-channel approximation was based upon modeling the channel as a small differential resistor with a value

$$R = dY / \rho A_c \qquad (1)$$

Where **σ** is the conductivity of the region as defined by Ohm's Law

$$\sigma = J / E \qquad (2)$$

With ***J*** the current density in units of and ***E*** the electric field intensity.



As drift current is due to charge moving under the influence of an electric field, ***J*** can also be expressed as

$$J = \rho_v V_e \qquad (3)$$

From gradual-channel analysis, the conductivity a MOSFET, is given by

$$\sigma = q\mu_n V_e \quad (4)$$

It is seen that this assumes that the electron velocity is proportiona lto the electric field such that

$$V_e = \mu_n E \quad (5)$$

With μ_n the mobility acting as the proportionality constant. This ignores two main features of the electron motion. First, the gate-source voltage that induces the field effect will alter the local electric field. This can be treated using the empirical expression for mobility is given by

$$\mu_{eff} = \frac{\mu_n}{\left[1 + \theta\left(V_{GS} - V_{Th} - V(y)\right)\right]} \quad (6)$$

where μ_n is the “normal” surface mobility.

θ is an empirical constant .

V_{GS} Gate Source Voltage.

V_{Th} Threshold voltage.

And $$V(y) = \frac{V_{DS}(y)}{L}$$

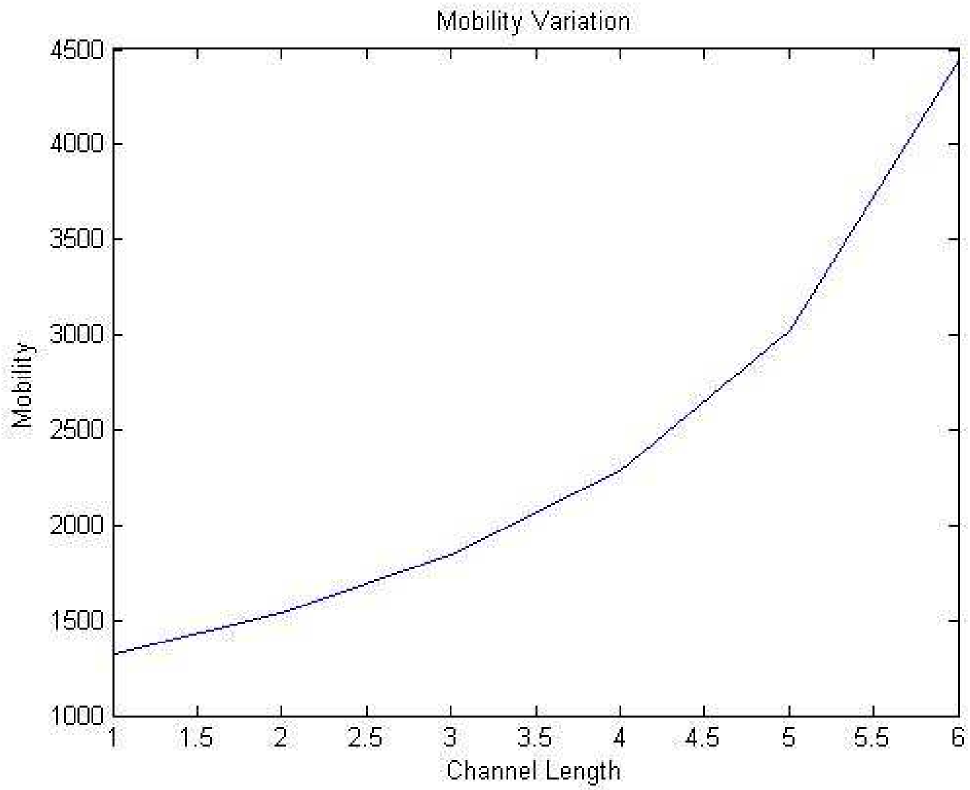
with L = channel length and

V_{DS} = Drain to Source Voltage.

MATLAB Program to calculate mobility:

```
clc;
close all;
clear all;
q=1.6*10^-19;
vgs=5;
vds=15;
esi=11.2*8.854*10^(-12);
ni=1.45*10^16;
na=10^24;
m=1350;
fi=0.0259*log(na/ni);
xdm=sqrt((4*fi*esi)/(na*q));
tox=xdm/4;
eox=3.9*8.854*10^(-12);
cox=eox/tox;
l=10*xdm;
qb=sqrt(q*4*na*esi*fi);
for n=1:6
v(n)=(vds*n/6)
x(n)=xdm-xdm*n/12
vt(n)=2*fi+qb*x(n)/(cox*xdm);
me(n)=m/(1+0.06*(vgs-vt(n)-v(n)))
end
plot(me)
xlabel('Channel Length');
ylabel ('Mobility');
title('Mobility Variation');
```

Graph Obtained:



Conclusion :

From the above figure it is seen that mobility varies with channel length exponentially.

Submitted By : SUJIT KU. NAYAK
ROLL NO : ELD09006