Submission Date: 29/04/2020 **Experiment No:7**

Analog Experiment-7

Title:

Design a supply independent current reference also known as beta multiplier

Objective:

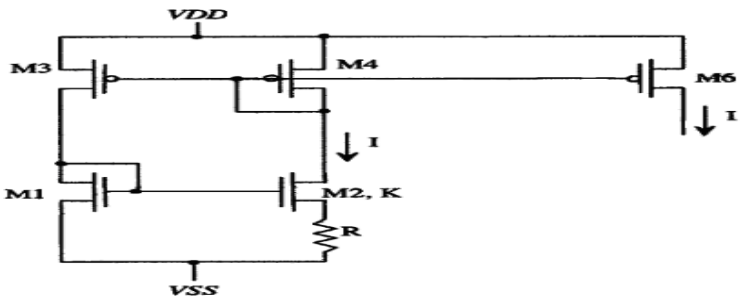
Design a beta multiplier circuit to obtain a reference current of 100uA. Plot the reference current variation w.r.t. supply voltage VDD. Calculate the current sensitivity to supply voltage.
Design a modified beta-multiplier as shown in the next section and plot the reference current variation w.r.t. supply voltage VDD. Calculate the current sensitivity to supply voltage.

Components/Tools Required:

Ltspice

Theory:

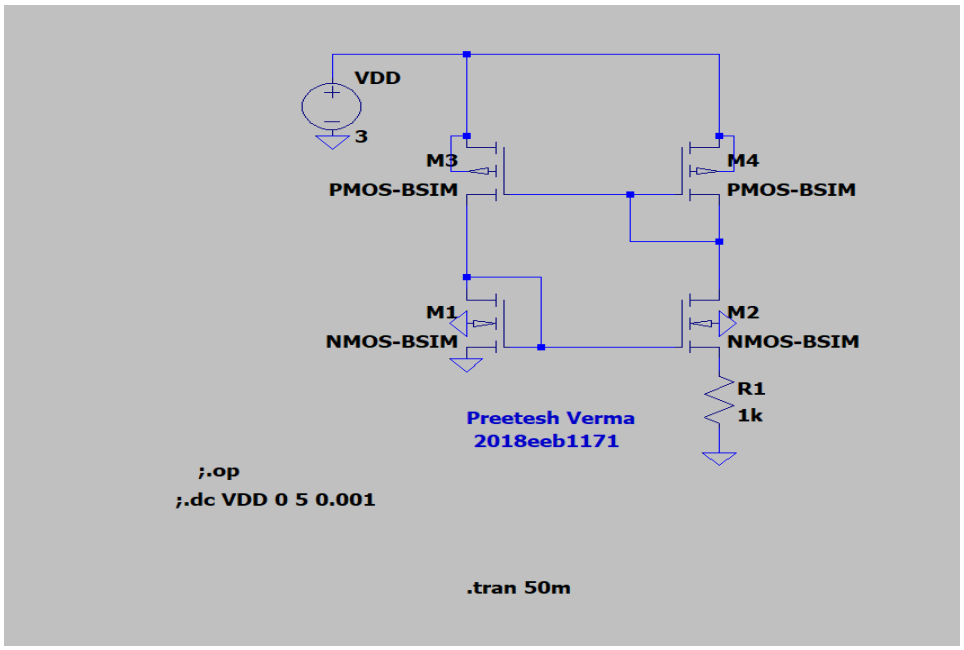
Beta multiplier circuit (self-biasing technique) improves upon power supply dependency. Given below is the circuit diagram, with source degenerated (by resistor 'R'), output device (M2) that is referred to as a simple β multiplier is loaded by a simple NMOS current mirror, loaded by a simple PMOS current mirror with an additional mirroring device (M6) to copy I to the reference's output.



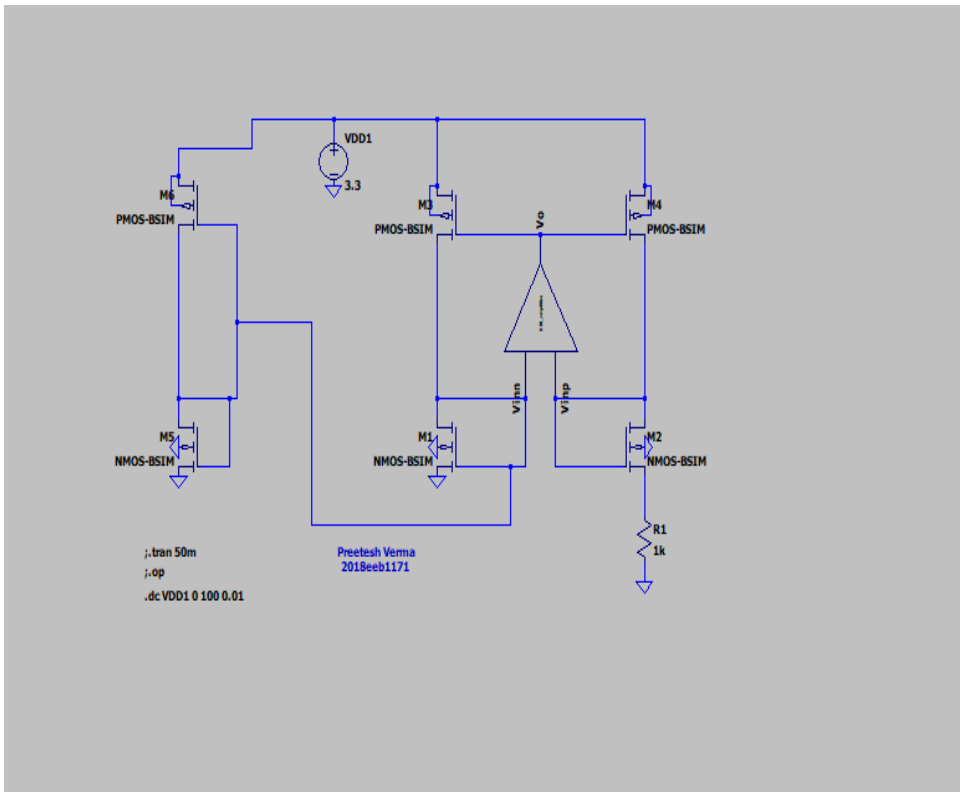
$$I = \frac{2}{R^2 \beta 1}\left(1 - \sqrt{\frac{1}{K}}\right)^2$$, where K is w/l of M2

Circuit Diagram:

Beta multiplier



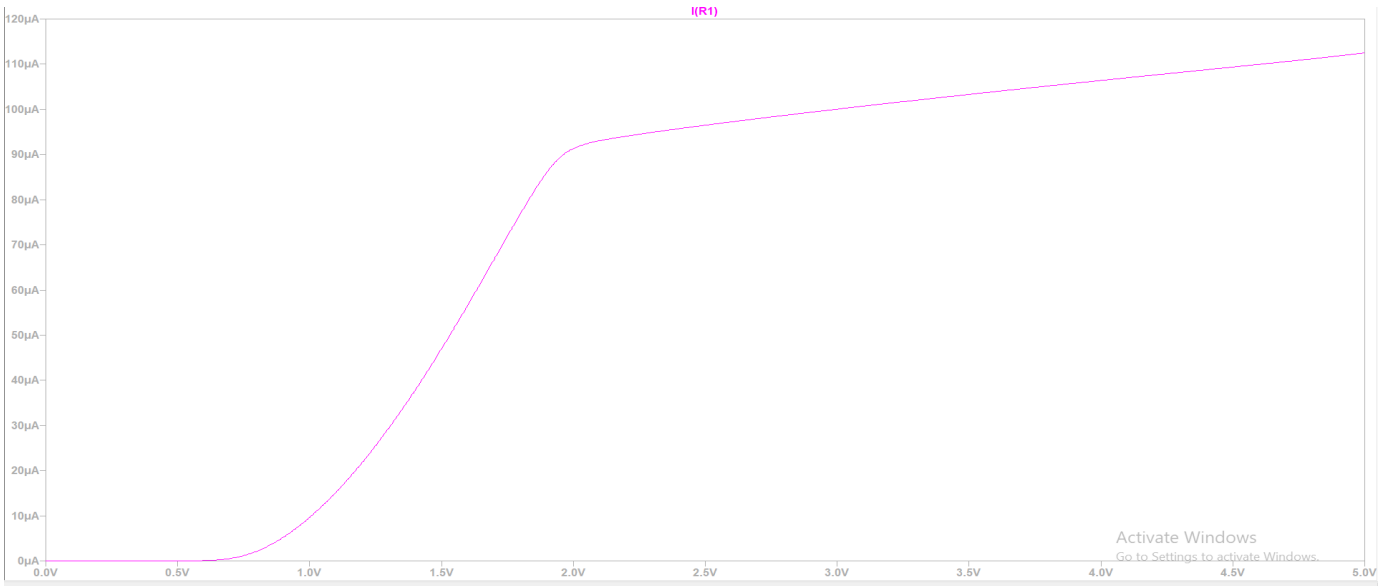
Modified Beta multiplier



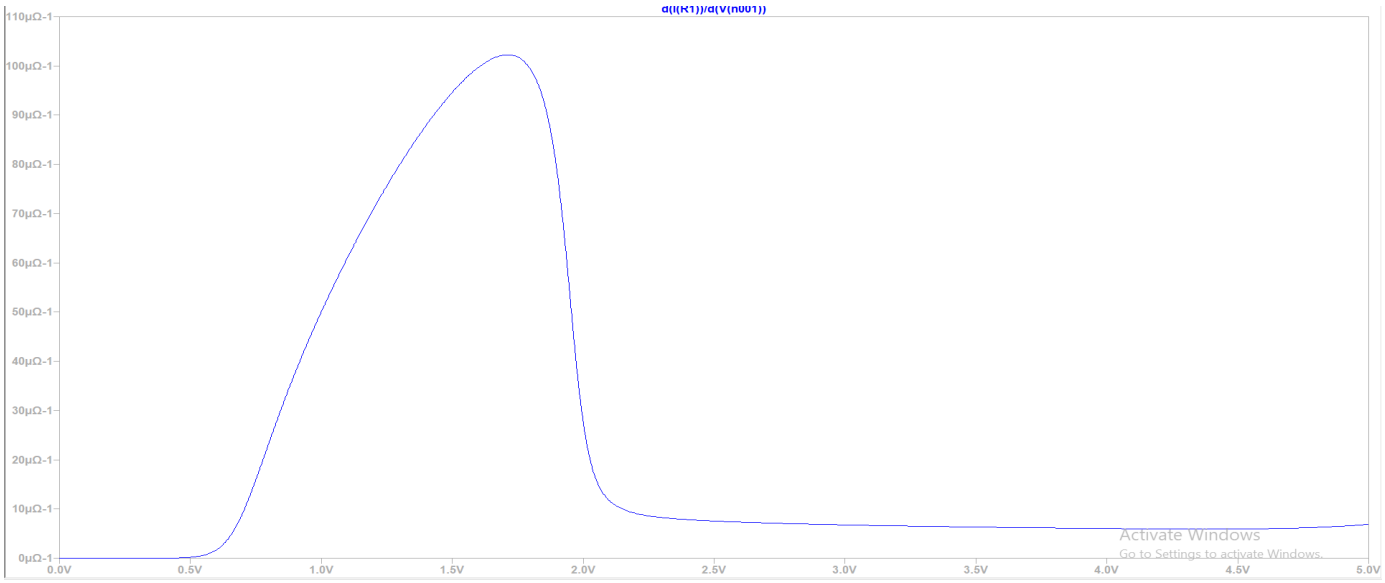
Waveforms:

- Beta multiplier

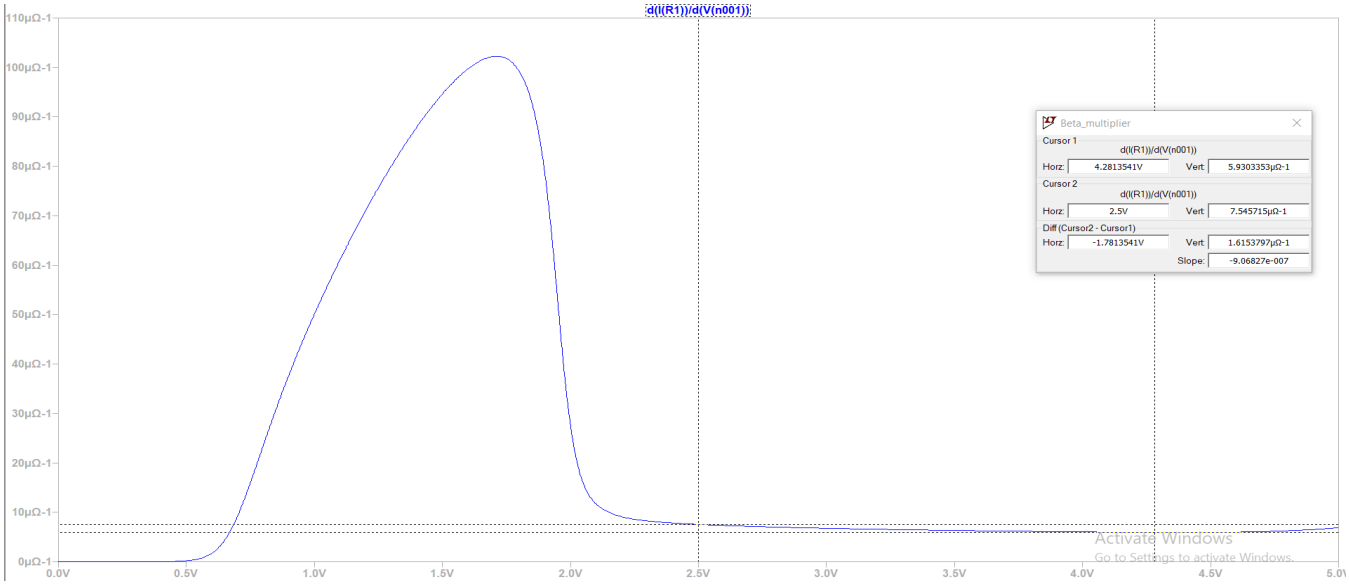
Id = I(R1) = 0.1mA = 100uA



Id vs Vdd



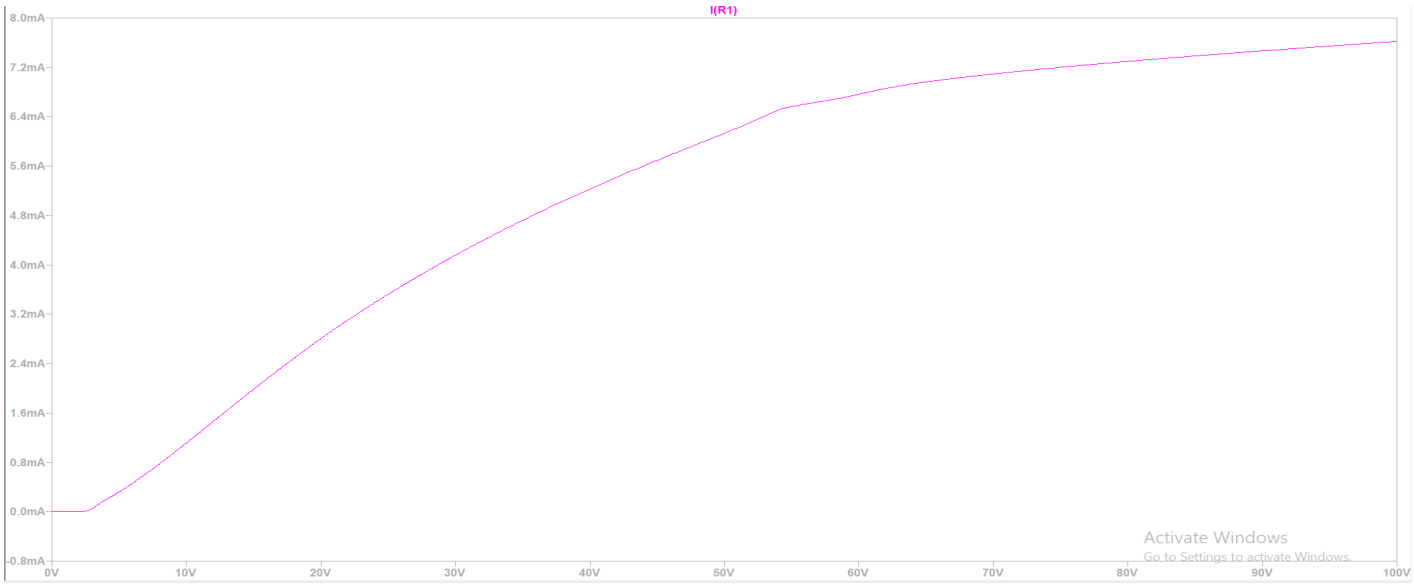
Sensitivity curve : $\frac{d(Id)}{d(Vdd)}$



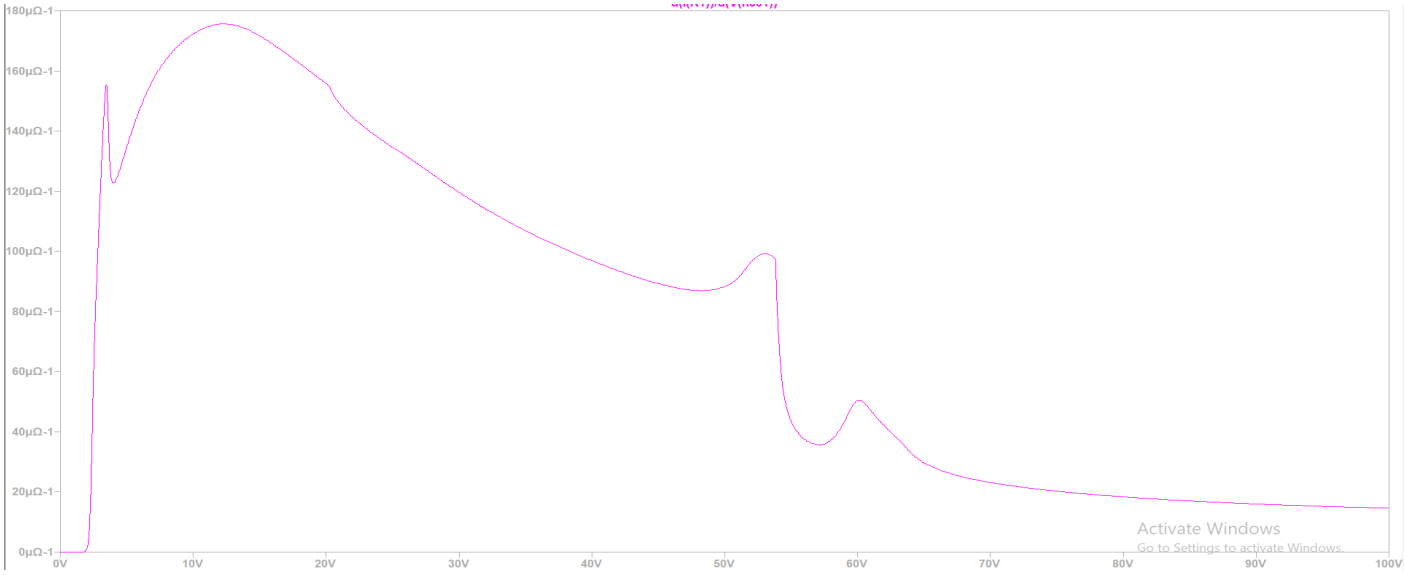
Sensitivity = 5.932 $\mu\Omega^{-1}$

- Modified Beta multiplier

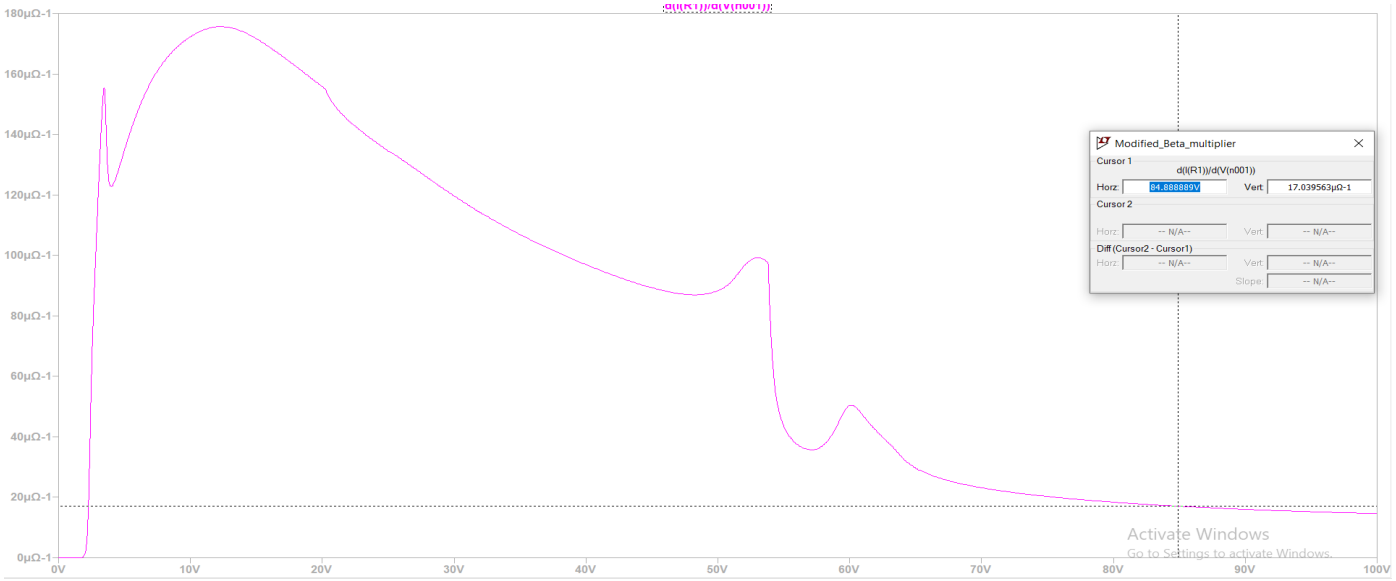
Id = I(R1) = 0.1mA = 100uA



Id vs Vdd



Sensitivity curve : $\frac{d(Id)}{d(Vdd)}$



Sensitivity: $17.063\mu\Omega^{-1}$