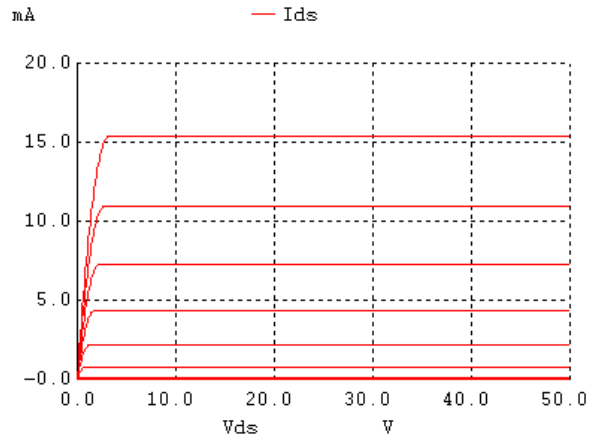


## SIMULATION EXERCISES WITH SPICE – PART 2 -

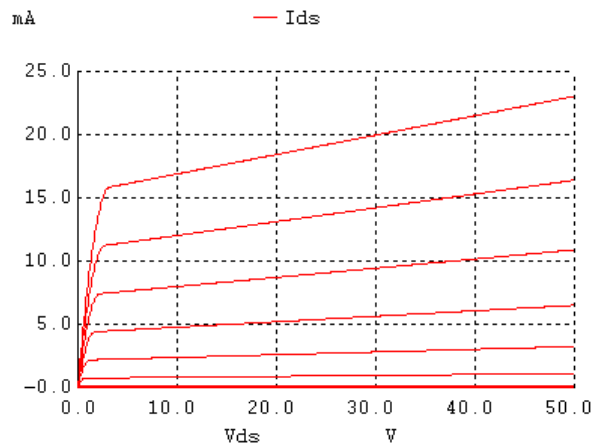
Dr. J. E. Rayas Sánchez

1. Write a SPICE netlist to obtain the output curves of a MOS transistor in common source configuration. Use an n-channel MOSFET with  $W/L = 40\mu\text{m}/2\mu\text{m}$ ,  $V_{TH} = 1.8\text{V}$ ,  $K_p = \mu_n C_{OX} = 150 \mu\text{A}/\text{V}^2$  (level 1 SPICE model). Vary  $v_{GS}$  from 0 to 5 volts with increments of 0.5V, and  $v_{DS}$  from 0 to 50 volts with increments of 0.1V.

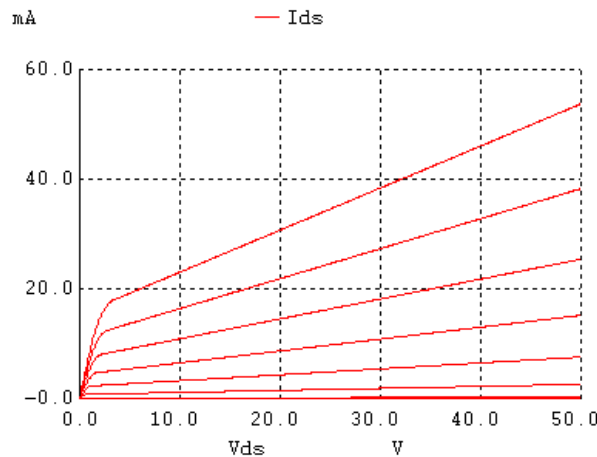
a) Using  $\lambda = 0$ , you should get:



b) Using  $\lambda = 0.01 \text{ V}^{-1}$ , you should get:

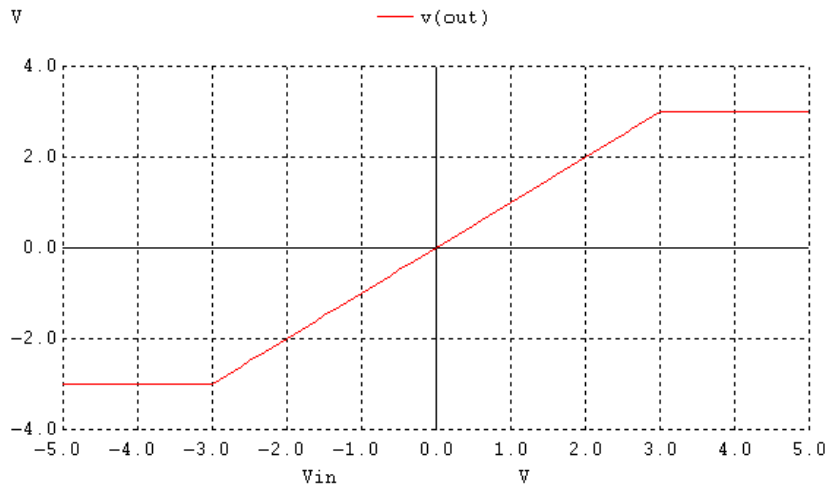
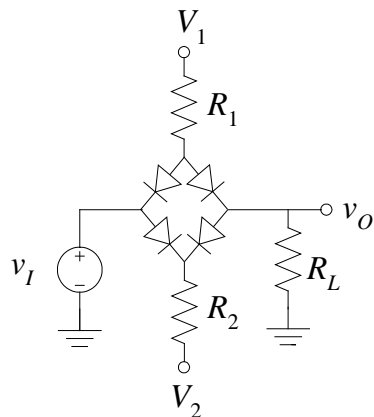


c) Using  $\lambda = 0.05 \text{ V}^{-1}$ , you should get:

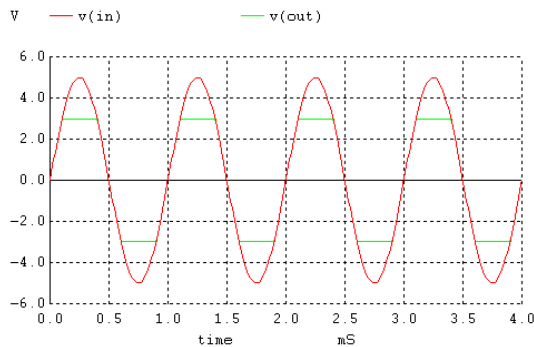


Notice the channel length modulation effects.

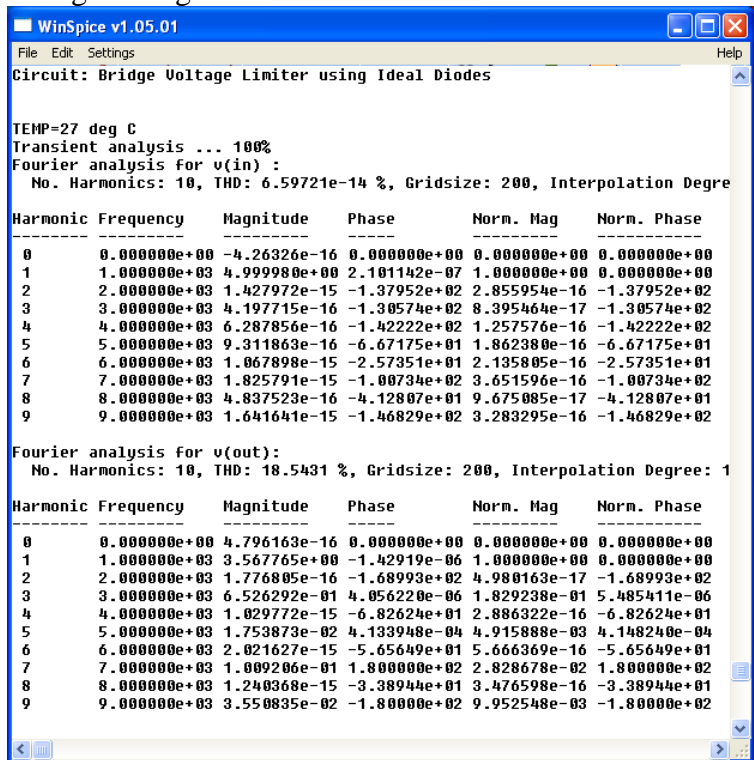
2. Obtain the large signal transfer function of the following Voltage Limiter, assuming  $V_1 = 3V$ ,  $V_2 = -3V$ ,  $R_1 = R_2 = 10\Omega$ ,  $R_L = 10K\Omega$  and ideal diodes. Vary  $V_I$  from  $-5V$  to  $5V$ .



Apply a 5V, 1KHz, sinusoidal input signal and plot the output voltage from 0 to 4 ms, using a plotting time step of  $1\mu s$ :



Obtain the spectrum of the input and output transient voltages using a SPICE Fourier command:



Now use diodes 1N4004 and repeat the analysis. Notice that the Total Harmonic Distortion at the output increased from THD=18.54% to THD=21.60%

Using again diodes 1N4004, increase the amplitude of the sinusoidal input voltage from 5V to 10V, and obtain again the Fourier components of the output voltage; notice that THD increases to 34.5%.