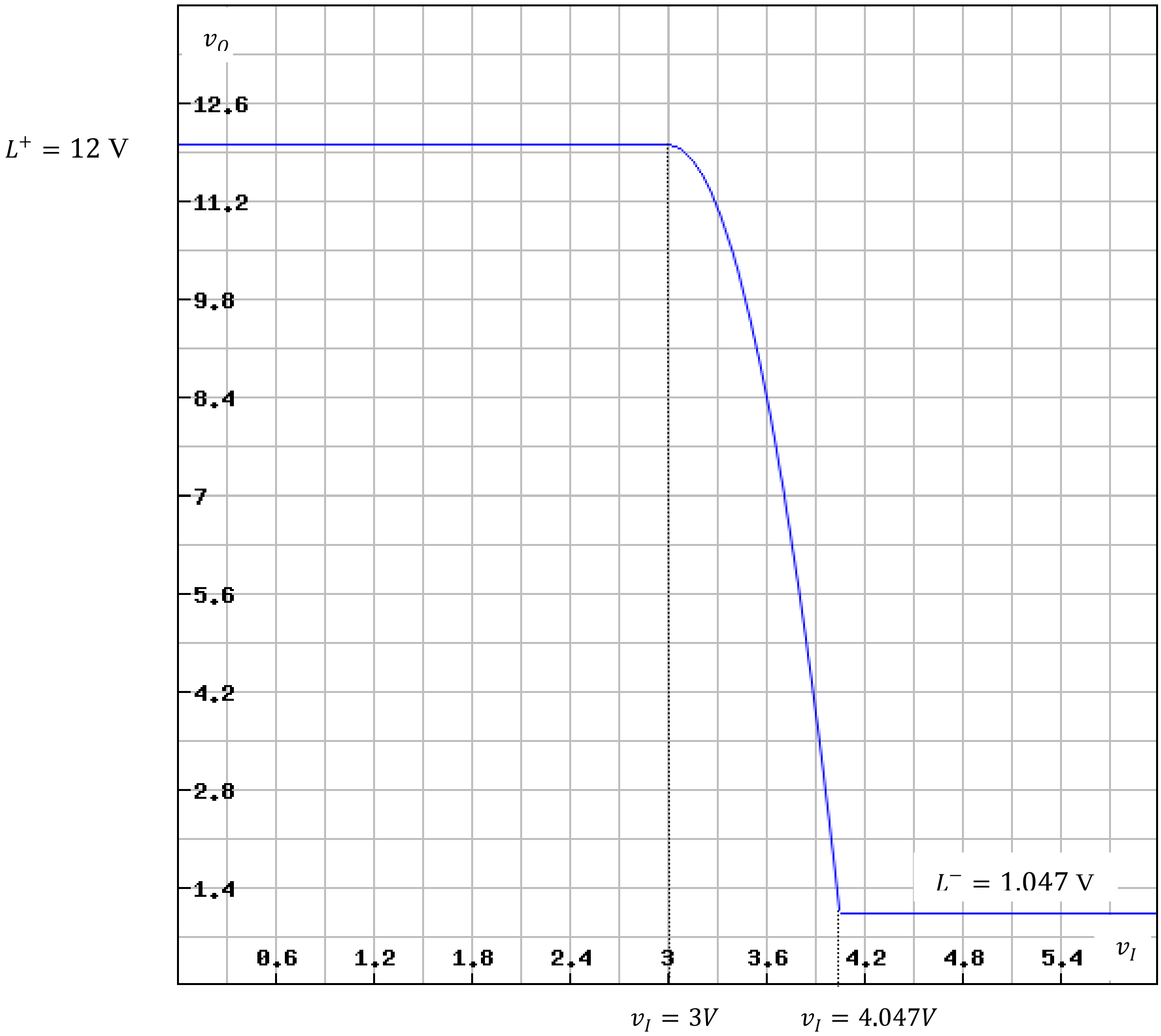
American University of Beirut
Department of Electrical and Computer Engineering

EECE 310 – Electronics   Fall 2011 – 2012

Homework 1

Problem 1

a) $v_O = 12 - 10(v_I - 3)^2$ for $3 < v_I < v_O + 3\,V$.
At $v_I = 3\,V, v_O = 12\,V$.
At $v_I = v_O + 3, v_O = 12 - 10{v_O}^2$.
Solving $10{v_O}^2 + v_O - 12 = 0$ gives $v_O = 1.047\,V$ or $v_O = -1.147\,V$.
Since $v_O > 0\,V, v_O = 1.047V$ at $v_I = 4.047V$.
Thus the saturation levels are $L^+ = 12\,V$ at $v_I = 3\,V$, and $L^- = 1.047V$ at $v_I = 4.047V$.



b) $v_O = 12 - 10(v_I - 3)^2$

To obtain $v_O = 6\,V$, the required input voltage is:

$$6 = 12 - 10(v_I - 3)^2$$
$$(v_I - 3)^2 = 0.6$$

Since $v_I > 3\,V,\ v_I = 3 + \sqrt{0.6} = 3.77\,V.$

c) $A_v = (dv_O/dv_I)|_{v_I=3.77}$
$dv_O/dv_I = -20(v_I - 3);$
$A_v = -20(3.77 - 3) = -15.4V/V$.
In dB $A_v = 20\log(15.4) = 23.75\ d$B.

d) $v_I = V_I + V_i\cos(\omega t)$

$v_O = 12 - 10(v_I - 3)^2 = 12 - 10(V_I + V_i\cos(\omega t) - 3)^2$

$v_O = 12 - 10((V_I - 3)^2 + (V_i\cos(\omega t))^2 - 2(V_I - 3)V_i\cos(\omega t))$

$v_O = 12 - 10\left((V_I - 3)^2 + (V_i)^2\left(\frac{1+\cos(2\omega t)}{2}\right) - 2(V_I - 3)V_i\cos(\omega t)\right)$

$v_O = 12 - 10(V_I - 3)^2 - 5(V_i)^2 - 5\,(V_i)^2\cos(2\omega t) + 20(V_I - 3)V_i\cos(\omega t)$

DC component= $12 - 10(V_I - 3)^2 - 5(V_i)^2$; where $V_I = 3.77\,V$.

$A_2 = -5(V_i)^2$

$A_1 = 20(V_I - 3)V_i$

$\left|\frac{A_2}{A_1}\right| = \frac{V_i}{4(V_I-3)} < 0.01;$ so that $V_i < 0.04(V_I - 3) = 0.04(3.77 - 3) = 0.0308\,V.$

Problem 2

a) The output saturation is ± 11V. The *peak-to-peak* value of the largest sinusoidal wave is 0.5V. Since the amplifier has linear transfer function $A_v = \frac{11-(-11)}{0.5} = 44$ V/V, in dB $A_v = 20\log(44) = 32.87dB$.

b) The output power is $P_o = \frac{V_{orms}^2}{R} = \frac{\left(\frac{11}{\sqrt{2}}\right)^2}{32}$=1.89 W.

c) The power gain is $A_p = \frac{P_O}{P_{in}} = 189$ W/W.
In dB, $A_p = 10\log(189) = 22.76$ dB.

$A_i = \frac{A_p}{A_v} = \frac{189}{44} = 4.295$ A/A. In dB, $A_i = 20\log(4.295) = 12.66\ dB$.

d) $\eta = \frac{P_L}{P_{dc}} \times 100$

P_{dc}=12.7*200+12.7*200=5080mW.

$\eta = \frac{1.89}{5.08} \times 100$ =37.02%.