Semester S1 –Basics of active and non linear electronics

RF Power amplifiers (JM Nebus)

TUTORIAL N° 2

I] Transistor biasing conditions and aperture angles

The static characteristic of a Field effect transistor is plotted in figure 1

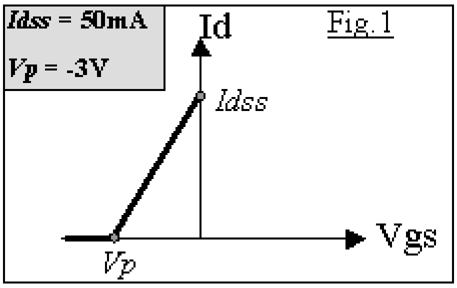


Figure 1

The simplified large signal equivalent model of the transistor is given in figure 2

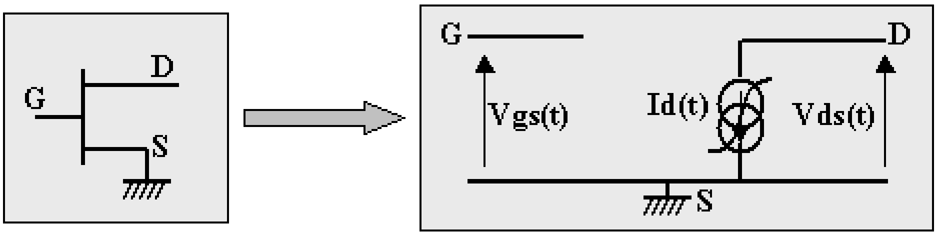


Figure 2

The transistor is connected to a sinusoidal voltage generator e(t) , DC voltage generators (Vgso and Vdso) and a load impedance (Zch) as represented in figure 3

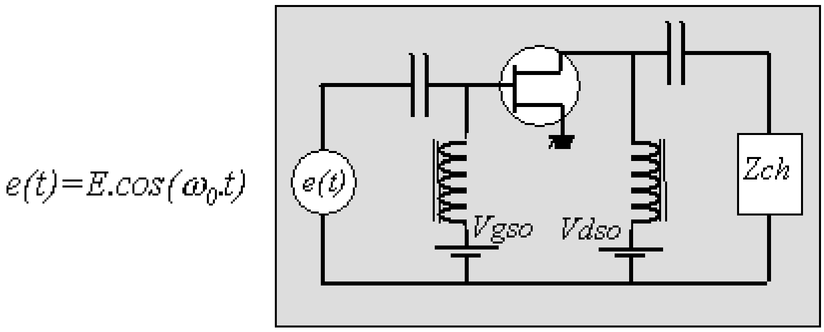


Figure 3

We will consider the study of four different cases respectively named

P1 , P2 , P3 , P4

P1: Vgso = -1.5 V and e(t) = 1.5 cos(w_0.t)

P2: Vgso = -2 V and e(t) = 2 cos(w_0.t)

P3: Vgso = -3 V and e(t) = 2 cos(w_0.t)

P4: Vgso = -4 V and e(t) = 3 cos(w_0.t)

For each one of the four cases

1) Plot the time domain waveforms of Vgs(t) and Id(t) on the graph given in Fig 1.

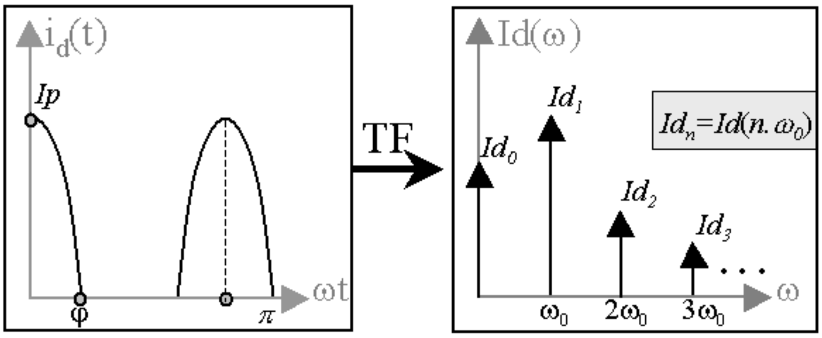
2) Calculate the aperture angle φ and the spectral components of the drain current Id (t):

(Id_o is the DC component and Id_1 is the fundamental frequency component)

3) If we choose Vgso=-2V, calculate the magnitude E of the input sinusoidal voltage in order to have an aperture angle equal to 160°

On donne: $\boxed{Id_0 = \frac{Ip}{\pi} \cdot \frac{\sin(\varphi) - \varphi.\cos(\varphi)}{1 - \cos(\varphi)}}$ et $\boxed{Id_1 = \frac{Ip}{\pi} \cdot \frac{\varphi - \sin(\varphi).\cos(\varphi)}{1 - \cos(\varphi)}}$

Ip is the peak value of the current



II Drain source voltage Vds(t) and load line

The DC drain source voltage is fixed at Vdso= 6V

The simplified Id versus Vds characteristic of the transistor is given in figure 4

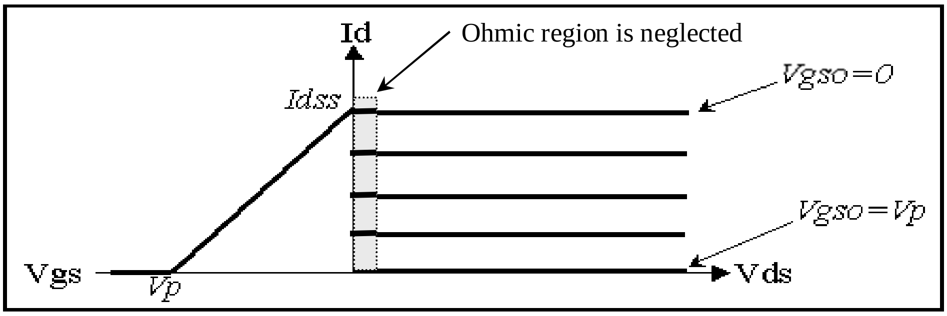


Figure 4

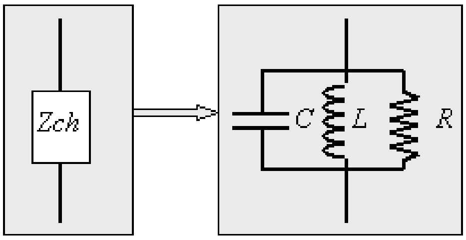
1) For the first case P1 , we choose Zch=240Ω.

Plot the shape of the drain source voltage Vds(t)

Plot the shape of the dynamic load line

2) Same question than 1) for the second case P2 and for Zch=200Ω.

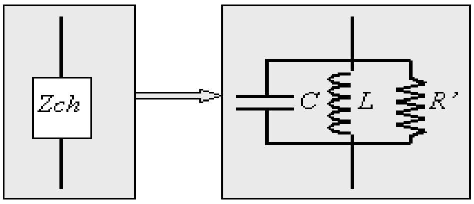
3) Same question for the third case P3 and for for a load impedance Zch composed of a parallel resonant circuit as represented below in figure 5 .



With $LC\omega_0^2 = 1$ et $R = 240\Omega$

Figure 5

4) For the last case P4 , we change the resistance of the parallel resonant circuit which is now R' as represented in Figure 6 . Calculate the value of R' in order to get a maximum magnitude of Vds(t). Plot also the corresponding load line .



$$LC\omega_0^2 = 1$$

Figure 6