Lecture 15 – MOSFET Amplifiers at High Frequencies

15.1 The High Frequency MOSFET Equivalent Circuit

The low frequency small signal model we have used so far for the common source amplifier allows us to calculate the ‘midband gain’, \( A_M \), see Bode plot below. For example:

\[
A_M \approx -g_m \left( r_o/R_D/R_L \right)
\]

which is equivalent to \( A_v \) from Lecture 14 for an amplifier driven by a signal generator with a low output resistance. To understand why the gain falls off at high frequencies (\( f > f_H \)) requires the use of a high frequency equivalent circuit.
15.2 The MOSFET High Frequency Small-Signal Equivalent Circuit

The high frequency, small-signal MOSFET model is shown inside the dashed lines of the figure above. We can use this model to estimate the unity-gain frequency, $f_T$, of a MOSFET by calculating the short circuit current gain $I_o/I_i$ (often called $h_{21}$).
15.3) Miller’s Theorem

\[ V_2 = KV_1 \]

\[ Z_1 = Z/(1 - K), \quad Z_2 = Z/\left(1 - \frac{1}{K}\right) \]
15.4) The Common-Source MOSFET Amplifier at High Frequencies

To determine the high frequency response we shall replace the MOSFET by its equivalent circuit. Note that in practice the capacitors $C_{C1}$, $C_{C2}$ and $C_S$ will be short circuits at the frequencies of interest (these capacitors in fact control the low-frequency response which will not be covered during this course). The result is the following circuit.

We will use Miller’s theorem to analyze the circuit.