Electronic Circuits – EE359A

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Lecture 8
Small Signal Graphical Analysis

- Signal is superimposed on DC voltage $V_{BB}$
- Corresponding to each instantaneous value of $V_{BB} + v_i(t)$ draw a load line
- Intersection of the $i_B - v_{BE}$ curve with the load lines
- Amplitude $v_i(t)$ small so $i_b$ linear
High Frequency $\pi$ Model
Transfer Function (s domain)
(a)

(b)

\[ \frac{V_o}{V_{sig}} \text{ (dB)} \]

**Low-frequency band**
- Gain falls off due to the effects of \( C_{C1}, C_{C2}, \) and \( C_E \)

**Midband**
- All capacitances can be neglected

**High-frequency band**
- Gain falls off due to the effects of \( C_\pi \) and \( C_\mu \) of the BJT

\[ 20 \log |A_M| \text{ (dB)} \]

\[ f_L \]

\[ f_H \]

\[ (\log \text{ scale}) \]
The given diagram and equations describe an electrical circuit. The circuit consists of various components such as resistors, capacitors, and transistors. The labels for the circuit components are as follows:

- $V_{\text{sig}}$: Input voltage
- $R_{\text{sig}}$: Input resistance
- $R_s$: Source resistance
- $r_{\pi}$: Parasitic resistance
- $g_m$: Transconductance
- $C_\pi$: Parasitic capacitance
- $C_\text{eq}$: Equivalent capacitance
- $R'_L$: Equivalent load resistance
- $V'_\text{in}$: Input voltage
- $I_\mu$: Transistor current
- $C_m$: Mu capacitance
- $V_o$: Output voltage
- $R'_L$: Equivalent load resistance

The equations derived from the circuit are:

- $V'_\text{sig} = \frac{V_{\text{sig}} R_R}{R_R + R_{\text{sig}}} \frac{R_{\pi}}{r_{\pi} + r_s + (R_{\text{sig}}/R_R)}$
- $R'_{\text{sig}} = r_s/[r_s + (R'_L/R_{\text{sig}})]$

The frequency response of the circuit is shown in the graph, which includes a 3 dB point and a $-6$ dB/octave slope. The frequency at which the gain drops to $-20$ dB/decade is given by:

- $f_H = \frac{1}{2\pi C_{\text{in}} R'_\text{sig}}$
(β + 1) \left( r_e + \frac{1}{sC_E} \right)

\begin{equation}
 f_{p2} = \frac{1}{2\pi C_E} \left[ r_e + \frac{R_B}{R_{ag}} \frac{1}{B + 1} \right]
\end{equation}

\begin{equation}
 f_{p3} = \frac{1}{2\pi C_{C2}} (R_C + R_L)
\end{equation}
Pspice of CE with Emitter Resistance

PARAMETERS:
- $CE = 10\, \text{u}$
- $CCI = 10\, \text{u}$
- $CCO = 10\, \text{u}$
- $RC = 10\, \text{K}$
- $RB = 340\, \text{K}$
- $RE = 6\, \text{K}$
- $Rce = 130$
- $RL = 10\, \text{K}$
- $Rsig = 10\, \text{K}$
- $VCC = 5$
- $VEE = -5$
Frequency Response

![Graph showing frequency response with key points: $f_L = 62.9\text{Hz}$, $A_M = 31.7\text{dB}$, $f_H = 287.1\text{KHz}$, $f_H = 145.8\text{KHz}$, $R_{ce} = 0\ \Omega$, $R_{ce} = 130\ \Omega$.](image-url)