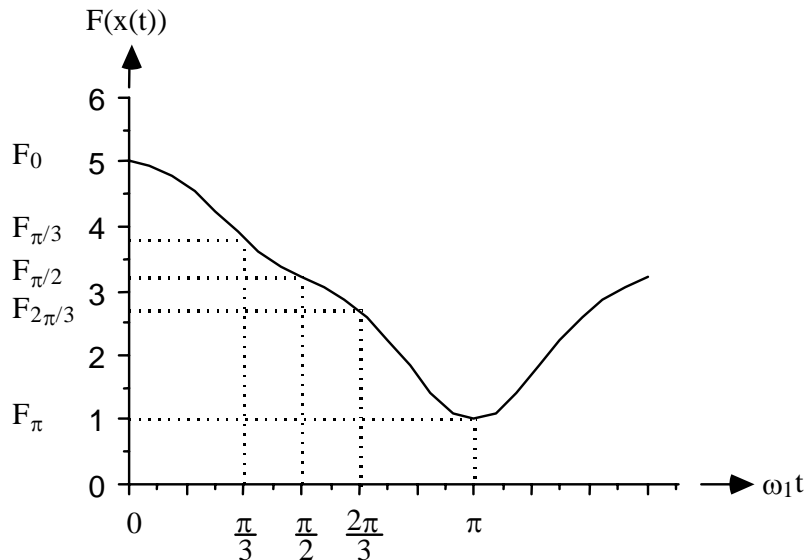


Homework #2 (Due Jan. 23)

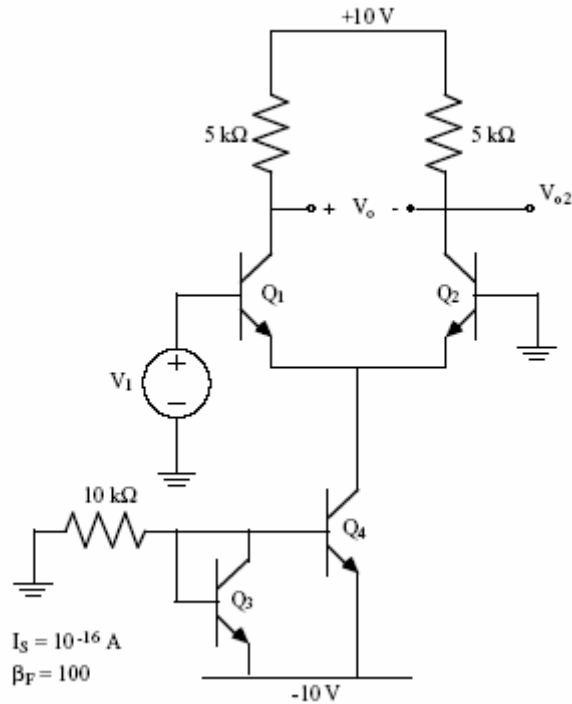
- For the following circuit configurations use hand calculations and SPICE (or SPECTRE, ADS) to determine the harmonic distortion. Assume the input signal to be a sinusoid at 10MHz with amplitudes of 10mV and 100mV, respectively. Use the following model parameters. BJT: $I_S=1e-16A$, $BF=100$, $V_A=100V$. MOSFET: $LEVEL=1$, $V_{TO}=0.7V$, $K_P=100\mu A/V^2$, $LAMBDA=0.01V^{-1}$. Compare the distortion factors for these circuits and comment on your results. Ignore compression and expansion terms in your hand calculations.



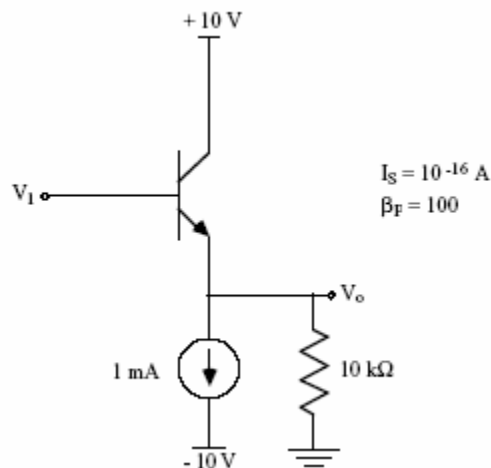
- The output waveform from a nonlinear circuit driven by a sinusoidal input signal is shown in the figure below. (a) Calculate HD_2 with the three point method. (b) Calculate HD_2 and HD_3 using the five point method. Note that $F_{\pi/3} = 3.8$, $F_{\pi/2} = 3.2$, $F_{2\pi/3} = 2.7$.



3. An emitter-coupled pair is shown in the figure below. (a) Determine the bias state of the circuit for $V_1 = 0$ V. (b) Calculate the small-signal gain from the input V_1 to the output V_{o2} . (c) Derive an expression that relates the large-signal collector current of Q2 (I_{C2}) to the input voltage V_1 (assume an ideal bias current source for the tail current). (d) For $V_1 = 20$ mV $\cos(2\pi 10^4 t)$, estimate the large-signal output response for both V_{o2} and V_o . (e) Estimate the harmonic distortion of V_{o2} using the series expansion method for an input amplitude of 20 mV. (f) Verify Parts (a) (b), (d) and (e) with Spice.



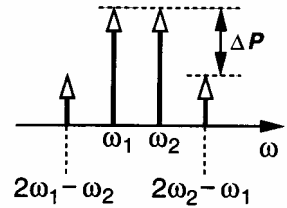
4. An emitter-follower circuit is shown in the figure. (a) Determine the bias state of the circuit. (b) For $V_1 = 4.4\cos(2\pi 10^4 t)$, estimate the large-signal output response for V_o . (c) Estimate the harmonic distortion of V_o for the condition of Part (b) using the five-point method and the differential error method for distortion analysis. (d) Verify the results of Parts (a) - (c) with Spice.



5. (a) Assume that signal levels are expressed in dBs, and the output spectrum for an input of two tones of equal amplitude is as shown in the figure. Show that

$$IIP_3 = \frac{\Delta P}{2} + P_{in}$$

where P_{in} is the input power.



- (b) Consider a cascade of n nonlinear gain stages where G_j and $(IIP3)_j$ are the power gain and input third-order intercept point, respectively for stage j . Assume that for stage j

$$v_{oj} = a_j v_{ij} + c_j v_{ij}^3$$

and $R_{in} = R_{out} = R_S$. Show that $(IIP3)_{total}$ is given by

$$1/(IIP3)_{total} = 1/(IIP3)_1 + G_1/(IIP3)_2 + G_1 G_2/(IIP3)_3 + \dots + G_1 G_2 \dots G_{n-1}/(IIP3)_n$$

Ignore expansion and compression terms. (*Hint: Use induction.*)