Problem Set 9

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1. Review of Important Concepts

   Assume a memory-less distortion circuit is modeled by
   $I_{out} = a_0 + a_1 V_{in} + a_2 V_{in}^2 + a_3 V_{in}^3$ and the input dc bias voltage is $V_{in,0}$.

   (a) Derive $IIP3$, $OIP3$, IP_{1dB}, and IP_{3dB}.

   (b) If $IIP3$ is 10 V, what is the input-blocker level that degrades the small-signal gain of the desired signal by 2 dB?

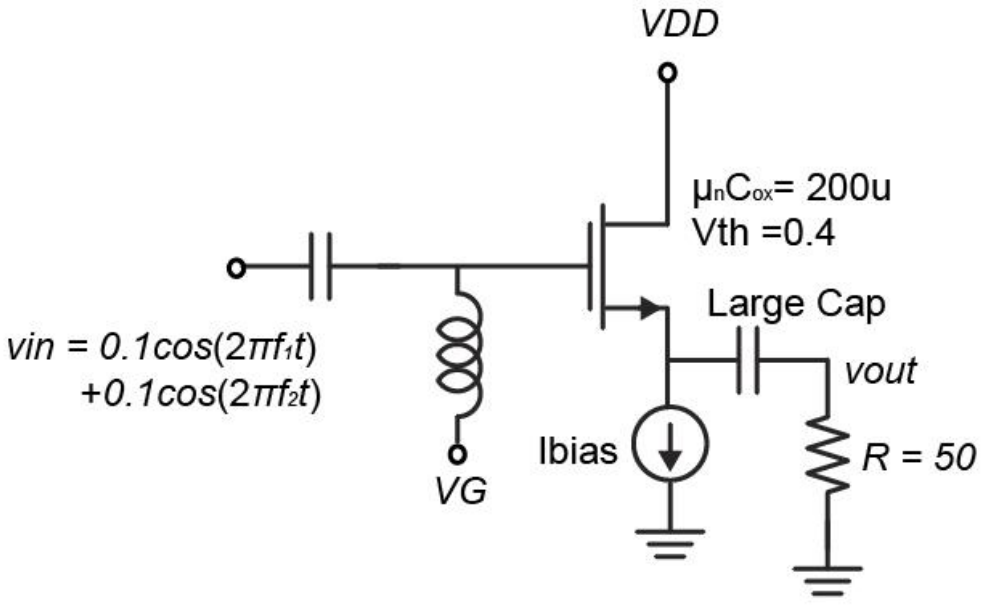
   (c) Following part (b), what will be the tolerable blocker levels for a two-tone blocker?

   (d) If $IIP3$ is 10 V, what are the IP_{1dB} for two-tone and three-tone input signals?

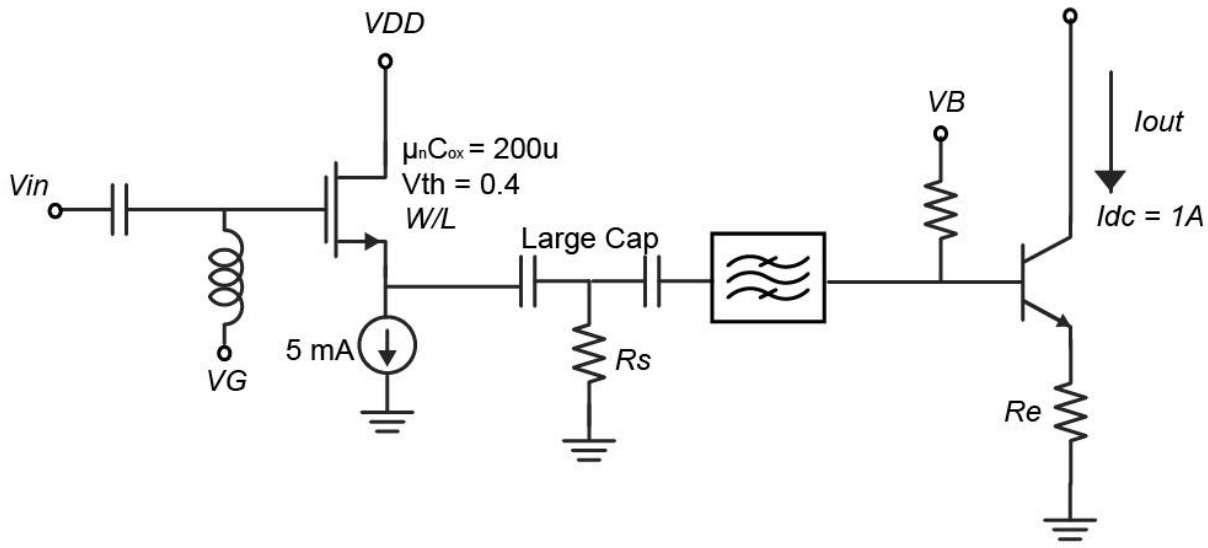
   (e) If the modeled circuit is a BJT with $I_{out} = I_s[exp(V_{be}/V_T)]$, use Math tool to find the actual output third-harmonic current as a function of the input magnitude. Compare the actual values to the estimated values via the power series.

2. Distortion of a Source Follower

   (a) For the source follower shown below. Calculate the required bias current (I_{bias}) and W/L for the long-channel transistor to drive the load with a swing of 100 mV (at both f_1 and f_2), with $IM3$ equal to -50 dBc.



3. Pre-distortion and Source-degeneration Linearizer



(a) For the above schematic, what are the $OIP3$ of the BJT stage for $R_e = 0\Omega$ and $R_e = 0.02\Omega$?

(b) What are the two possible R_e for the BJT stage to have an $OIP3$ of $10A$?

(c) (242 Only) Following part(b), a source follower is placed before the BJT stage in order to achieve a cascade $OIP3$ better than the BJT-stage $OIP3$ ($10A$). Is this linearization approach feasible for both the R_e you found in part(b)? (There is an ideal BPF that only passes the fundamental and the IM3 components, so the cascade IIP3 formula is exact.)

(d) (242 Only) Using one of the two R_e you found in part(b) for the BJT-stage $OIP3$ of $10A$, continue to design the source follower with a fixed bias current of $5mA$ to achieve (i) cascade $OIP3$ of $20A$ and (ii) the highest voltage gain for the source follower. The design variables are the FET size W/L and the feedback resistor R_s.

(e) (242 Only) Verify you design in part(d) via ADS Harmonic-balance simulation.