E151 Lecture 21 – More Differential Pairs

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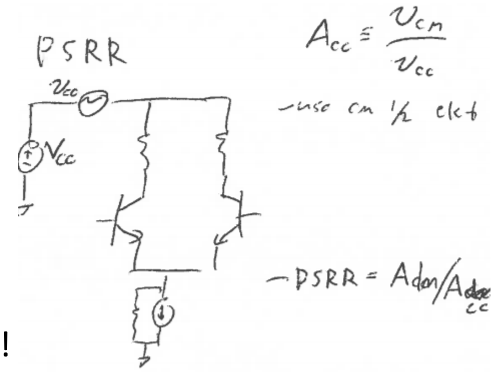
ENGR151

Disclaimer

These are notes for Prof. Spencer to give the lecture, they were not intended as a reference for students. Students asked for them anyway, so I'm putting them up as a courtesy. Remember that they are not intended as a substitute for attending lecture.

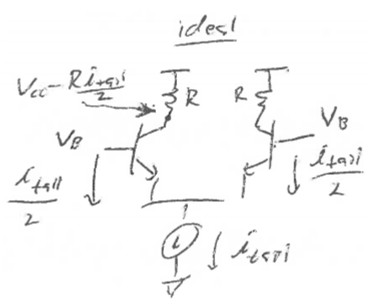
Some Odds and Ends

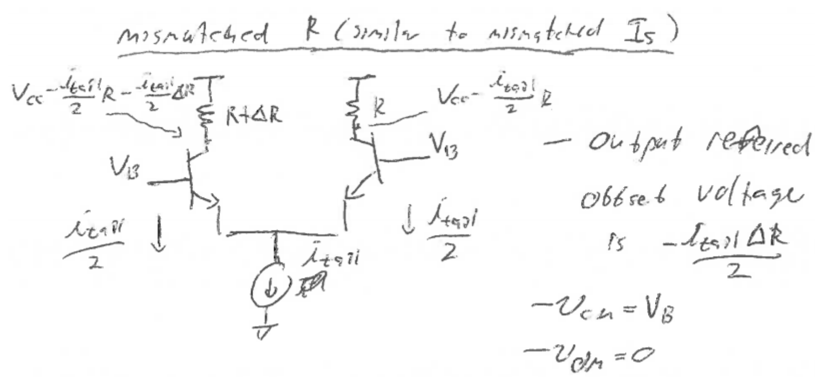
- Note adm is from vdm/2 to vodm/2
- Also note this doubles **rin,dm! =2rpi**
- Be clearer about input and output differential signals, vi+/- and vo+/-
- Recall CMRR=adm/acm … similarly **PSRR=adm/acc** w/ acc=vcm/vcc
- Note: have OCTC_dm and OCTC_cm too!
- Finish CTLE … CM omits Ze, DM sees 0.5x Ze to ground (R/2 || 2C)
- Intuition: purely cm changes don't change current into Re, so omit



Offsets

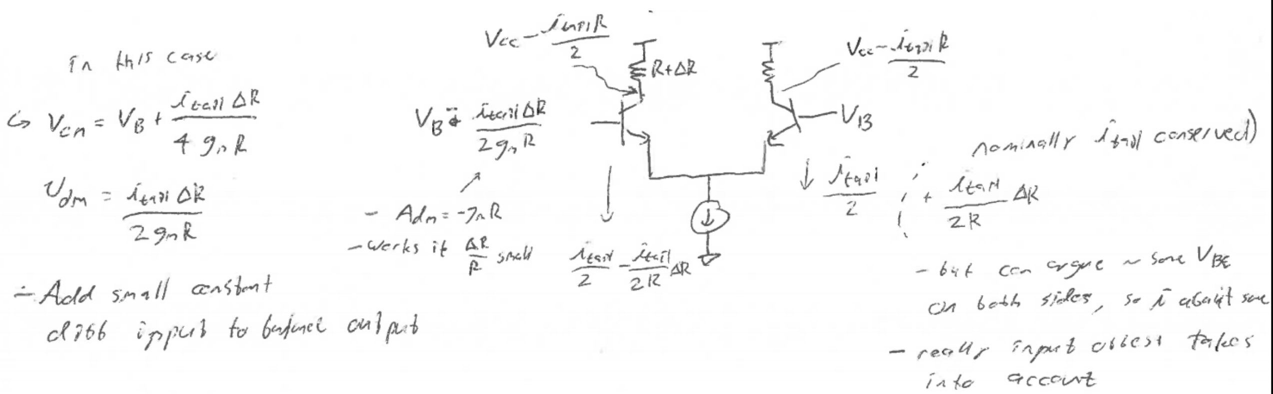
- If transistors and resistors aren't identical you get offsets





(This assumes current still splits evenly, okay if dr is small)

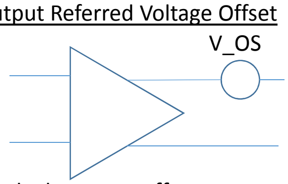
Input and Output Referred Offsets



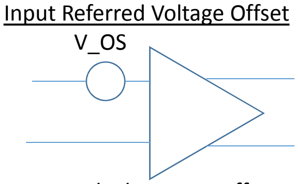
- We can adjust our input vdm so the output vdm = 0.
- This is an input-referred offset. Can't tell difference 1 stage away.

Adding Offsets to an Amplifier Model

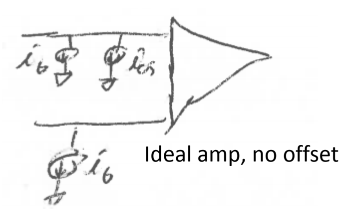
Output Referred Voltage Offset



Input Referred Voltage Offset

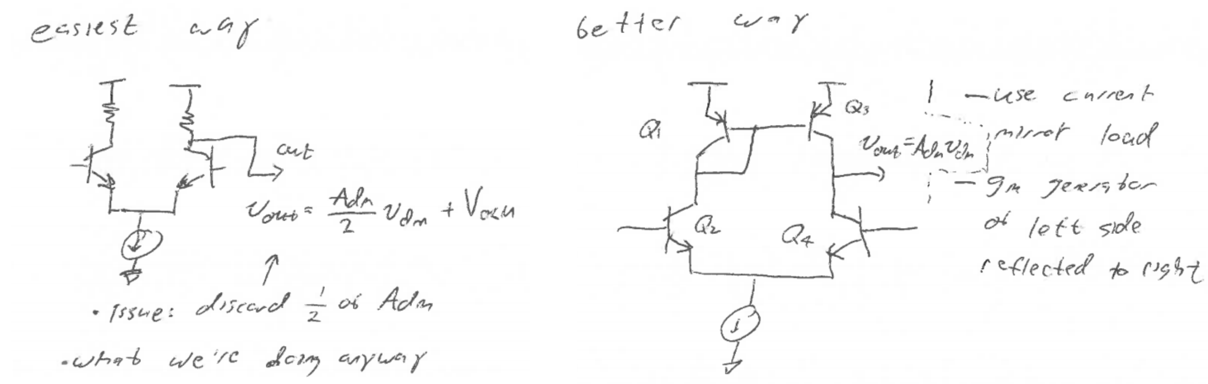


Input Referred Current Offset and Bias Current



- Note that they are DC, matters more for op-amps than our mid-band
- We can also add a parameter called input bias current, I_IN
- I_IN ~ I_T/2*beta for a DC-coupled emitter coupled pair. (0 for AC)

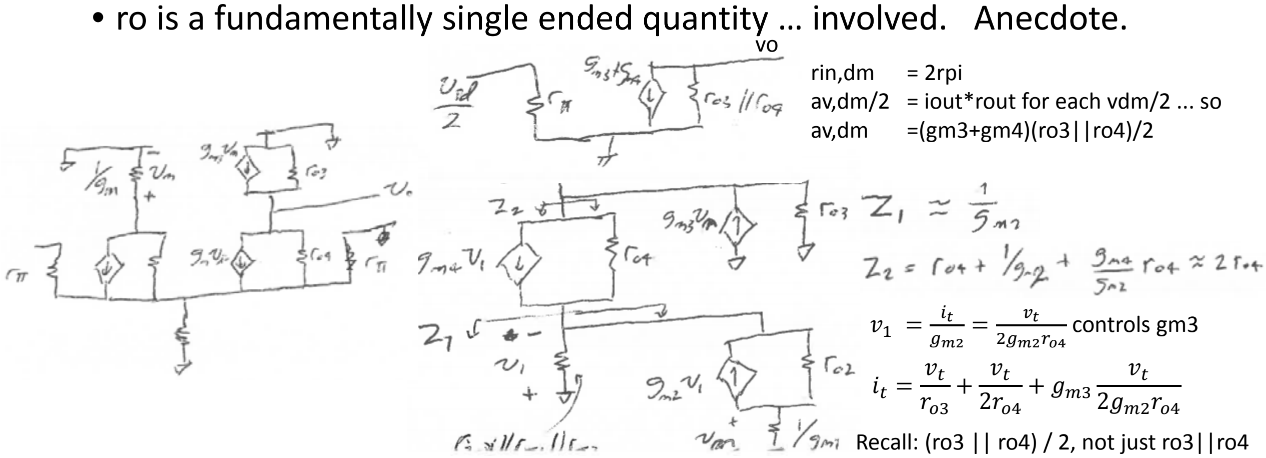
Differential to Single-Ended Conversion



- Op-amps want differential input and single-ended output.
- There are alternatives: we'll talk about baluns in lab.

Analyze Mirror Loaded Emitter Coupled Pair

- rin,dm unaffected by load, whew. Both sides help av,dm.
- ro is a fundamentally single ended quantity … involved. Anecdote.



rin,dm = 2rpi

av,dm/2 = iout*rout for each vdm/2 ... so

av,dm =(gm3+gm4)(ro3||ro4)/2

$v_1 = \frac{i_t}{g_{m2}} = \frac{v_t}{2g_{m2}r_{o4}}$ controls gm3

$i_t = \frac{v_t}{r_{o3}} + \frac{v_t}{2r_{o4}} + g_{m3}\frac{v_t}{2g_{m2}r_{o4}}$

Recall: (ro3 || ro4) / 2, not just ro3||ro4