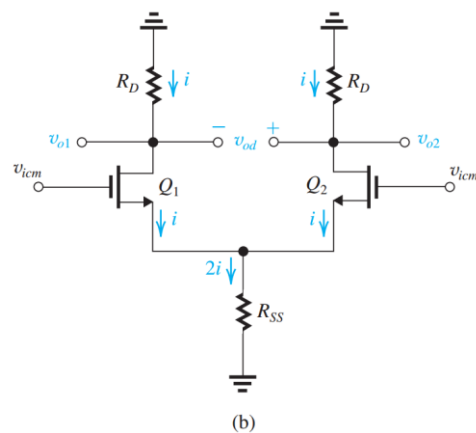
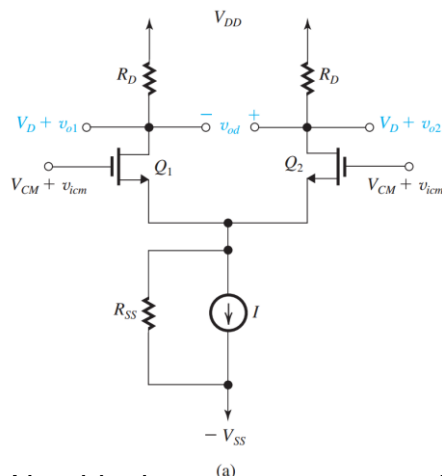


EE112 - Fall 2016

Analog Integrated Circuits I

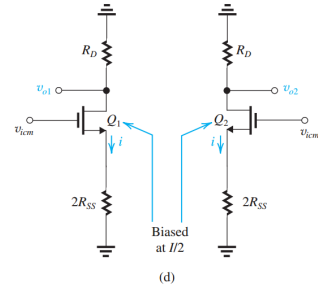
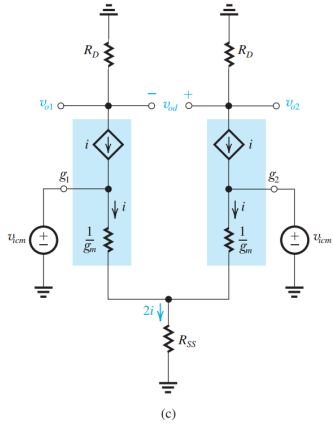
Prof. Haoyu Wang
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 5210 Research Bldg.

AC Equivalent Circuit for Common Mode Input



- Non-ideal current source consists of an ideal current source, shunted by a large resistance, R_{SS} .

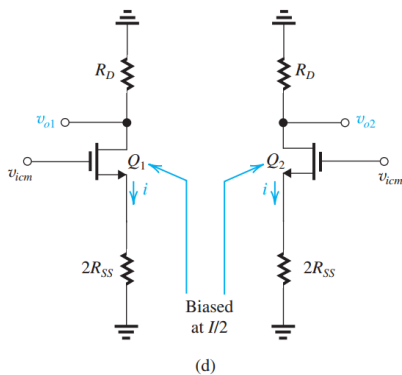
Common Mode “Half Circuit”



- For differential inputs, the two half circuits are anti-symmetric, and the joint (Source) is always at virtual ground

- For common-mode inputs, the two half circuits are symmetric. The Source is not virtual ground any more.
- R_{SS} can be considered as two parallel combination of R_{SS} .
- Each CM half circuit has $2R_{SS}$ connected to the source.

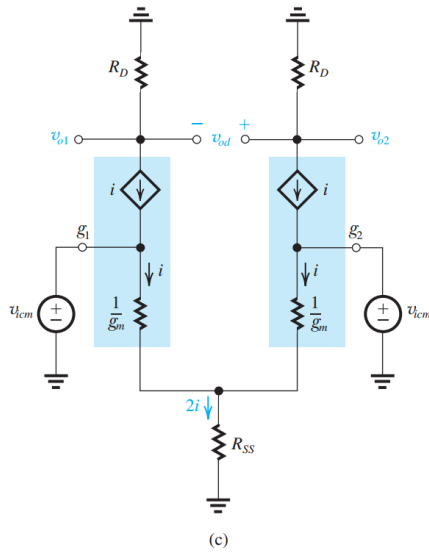
Ideal CM Output Voltage



- Common-Source with degeneration

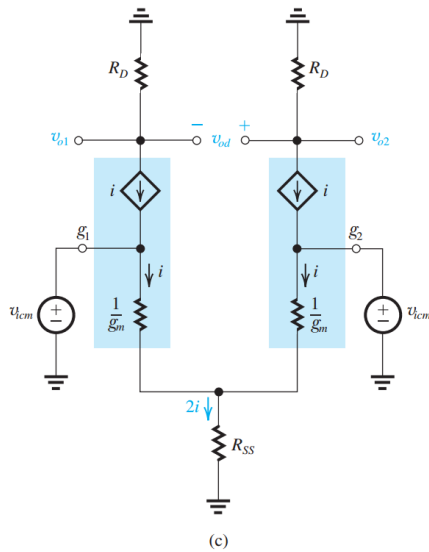
- V_{od} is 0 for ideal diff pair
 - 1. perfectly matched transistors and resistors
 - 2. Small CM voltage to keep Q1&Q2 in saturation.

Common Mode Gain with Mismatched R_D



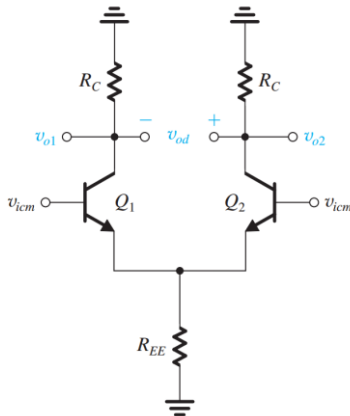
- However, any mismatch in the half circuits will produce finite output voltage.

Common Mode Gain with Mismatched g_m

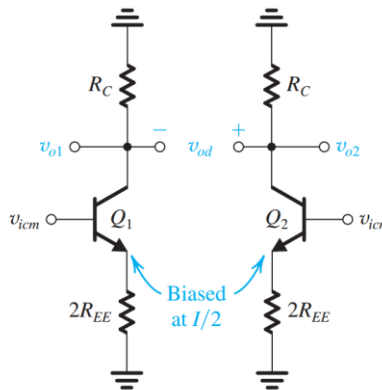


BJT Differential Amplifier

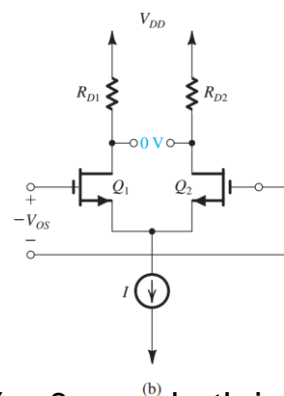
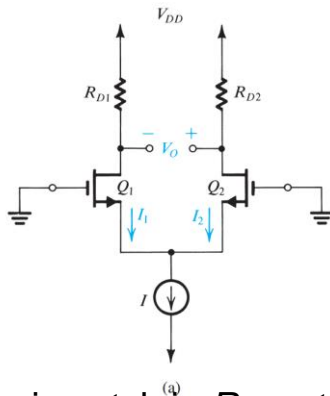
Differential Amplifier



Half Circuit

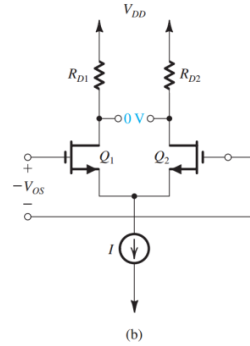
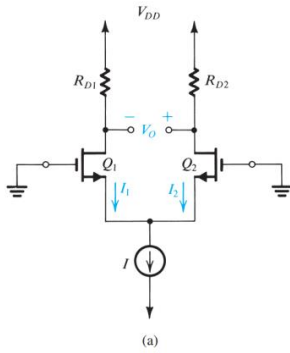


DC Offset

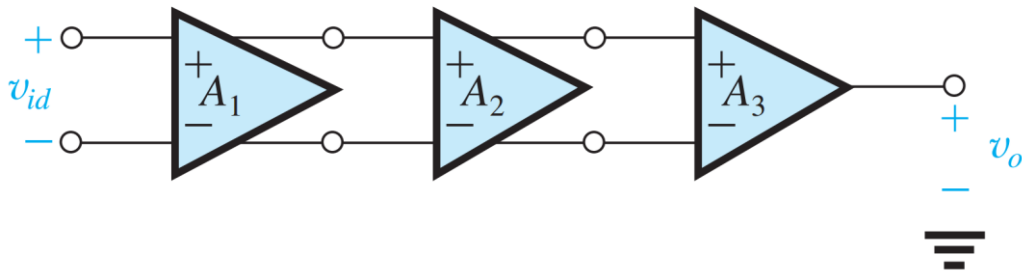


- Due to mismatch in R_D , output voltage $V_o \neq 0$ even both inputs are grounded.
- To produce 0 output, an **input offset voltage** $V_{OS} = V_o/A_d$. Where A_d is differential gain, needs to be applied.

Continued

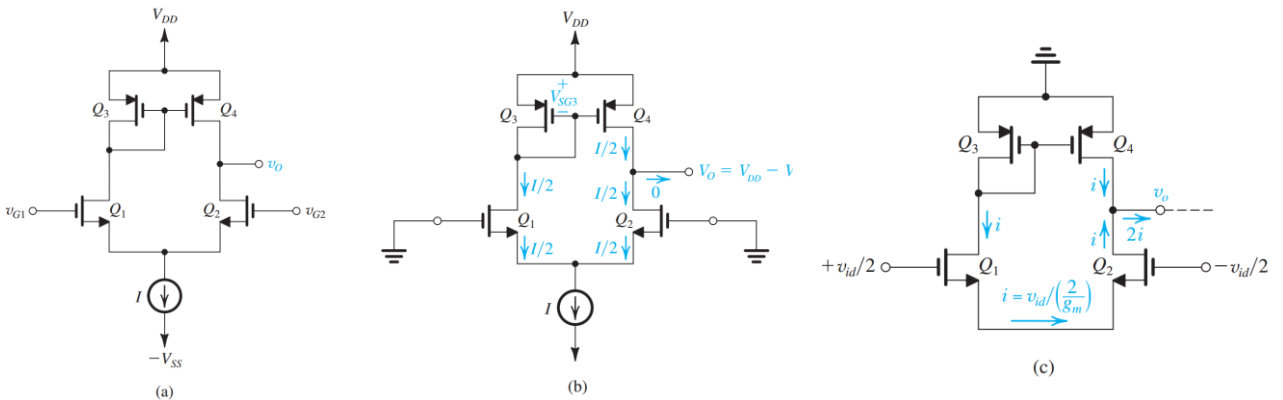


Differential Input, Single-End Output

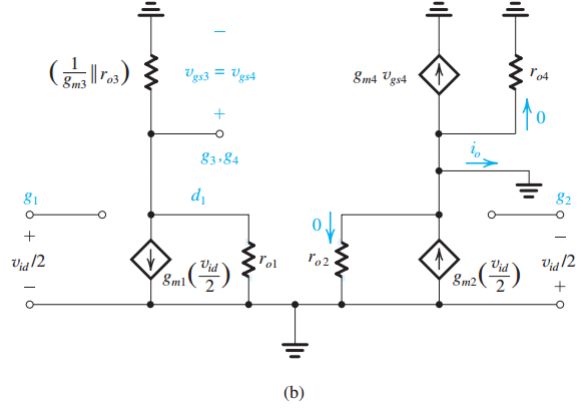
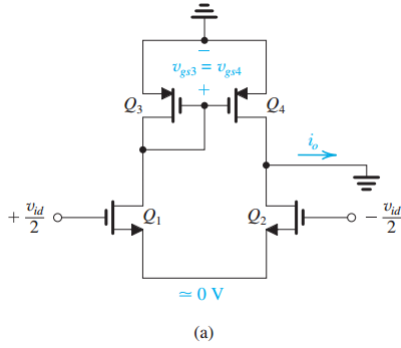


Review: Two Port Network

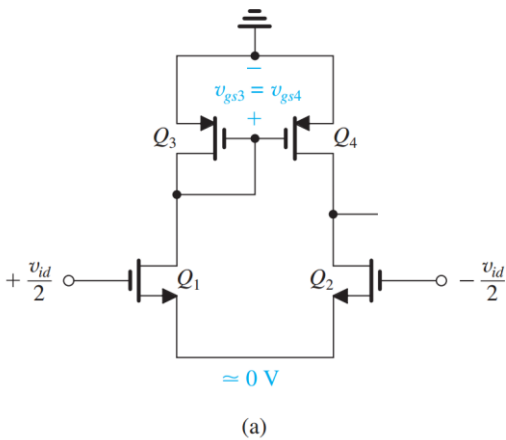
MOS Differential Pair with Current Mirror Load



Short Circuit Transconductance



Output Impedance and Differential Gain



Common Mode Gain

