

1. Does the transconductance of a MOSFET depend linearly on I_{DS} ? Why (please derive)?
2. To carry the same amount of current under the same bias conditions, should a PMOS transistor be made wider, narrower, or the same as a nearby NMOS? Why (in physical terms)?
3. Please sketch an NMOS differential amplifier with tail current of 1 mA (i.e., a current source of 1 mA between source node and ground). What happens to V_{SOURCE} when the common-mode input voltage is increased? Why?
4. Before the days of digital computers, or even calculators, if you wanted to electronically calculate the natural logarithm (\ln) of a number how could you do it? Please sketch and/or write equations to explain.
5. If you wanted to amplify the signal from a photodiode (which acts like a weak current source) with a common source amplifier, should you connect a resistor so as to form a series-x or a shunt-x feedback amplifier? Or is feedback not needed? Please explain.
6. Please describe the major sub-circuits of an op-amp, and the critical design considerations of each.