**DAILY ASSESSMENT FORMAT**

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| **Course:** | **VLSI design** | **USN:** | **4al16ec074** |
| **Topic:** | **MOS transistor** | **Semester & Section:** | **8-B** |
| **Github Repository:** | **shreya-test** |  |  |

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| **Image of session** |
| **Report** The MOS transistor The most basic element in the design of a large scale integrated circuit is the transistor. For the processes we will discuss, the type of transistor available is the Metal-Oxide-Semiconductor Field Effect Transistor (MOSFET). These transistors are formed as a ``sandwich'' consisting of a semiconductor layer, usually a slice, or wafer, from a single crystal of silicon; a layer of silicon dioxide (the oxide) and a layer of metal.  These layers are patterned in a manner which permits transistors to be formed in the semiconductor material (the ``substrate''); a diagram showing a typical (idealized) MOSFET is shown in Figure [gif](http://www.cs.mun.ca/~paul/transistors/node1.html#figmosfet). Silicon dioxide is a very good insulator, so a very thin layer, typically only a few hundred molecules thick, is required. Actually, the transistors which we will use do not use metal for their gate regions, but instead use polycrystalline silicon (poly).  Polysilicon gate FET's have replaced virtually all of the older devices using metal gates in large scale integrated circuits. (Both metal and polysilicon FET's are sometimes referred to as IGFET's --- insulated gate field effect transistors, since the silicon dioxide under the gate is an insulator. We will still continue to use the term MOSFET to refer to polysilicon gate FET's.)  Basic MOS transistor    The source and drain regions are quite similar, and are labeled depending on to what they are connected. The source is the terminal, or node, which acts as the source of charge carriers; charge carriers leave the source and travel to the drain. In the case of an N channel MOSFET, the source is the more negative of the terminals; in the case of a P channel device, it is the more positive of the terminals. The area under the gate oxide is called the ``channel''.  The MOSFET can operate as a very efficient switch for current flowing between the source and drain region of the device. For the simplest type of MOSFET, the ``enhancement mode MOSFET'', which acts as a ``normally open'' switch, the operation of the device can be described qualitatively with reference    The substrate, or body of the device, is also connected to ground. In this case, there is a reverse biased PN junction between at least one of the N wells and the substrate, so no current can flow through the substrate. In particular, there will be no current flow in the channel region under the gate of the transistor, and therefore no current will flow between the source and drain of the device. Under these conditions, the MOSFET is turned *off*.  Figure [gif](http://www.cs.mun.ca/~paul/transistors/node1.html#figenhancement)(b) shows the same N-channel MOSFET with a positive charge applied to the gate of the device. Under these circumstances, if the gate is given a sufficiently large charge, negative charge carriers (electrons) will be attracted from the bulk of the substrate material into the channel region immediately below the oxide under the gate.  When more electrons are attracted into this region than there are positive charge carriers (holes) in the channel, then the channel effectively behaves as an N type region, and current can flow between the source and the drain. When this happens, the MOSFET is turned *on*. Note that a certain minimum charge must be applied to the gate to overcome the excess of holes already in the channel region because of the P type doping in the substrate.  This means that the switch is not turned on immediately, rather there must be some minimum amount of charge applied to the gate before the transistor is switched on. The voltage which must be applied to the gate before the transistor allows current to flow between the source and drain is called the ``threshold voltage'', designated as .  This type of transistor is called an N channel enhancement mode MOSFET. (It is called N channel because the conduction in the channel is due to N type charge carriers; it is said to be an ``enhancement mode'' device because the channel conduction is enhanced by a charge applied  to the gate.) Figure [gif](http://www.cs.mun.ca/~paul/transistors/node1.html#figcharacteristics) shows a set of typical characteristic curves[gif](http://www.cs.mun.ca/~paul/transistors/footnode.html#262) for the current  between the drain and source of a MOSFET as a function of the voltage  for a range of gate voltages, . |