

Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science

6.111 -- Introductory Digital Systems Laboratory

General Laboratory Information

Each student will be issued his/her own Nubus Laboratory Kit, logic probe and oscilloscope probes. This kit contains most of the components for the assigned laboratory exercises. While wiring and some debugging can be done at home, most exercises require the use of an oscilloscope, logic analyzer, and other special equipment not included in the kit. In the Digital Systems Laboratory you will find logic analyzers with dual trace sampling oscilloscopes and the special equipment needed for the lab exercises. The lab will be open for 2 hour 45 minute through week days, 5 hour 45 minute on Saturday, and 11 hour 45 minute on Sunday. These times are subject to change and the lab will be closed on some holidays. Actual opening times will be posted in the lab far enough ahead so that you can make plans. The lab will not be staffed by Teaching Assistants (TAs) or Lab Aides (LAs) all of the open hours. The schedule of TAs and LAs will be available on the course web pages.

PUT YOUR NAME ON ANYTHING THAT YOU BUILD IN THE LABORATORY AND LEAVE UNATTENDED. OTHERWISE, IT MAY BE GONE WHEN YOU RETURN.

It is important to remember that you will be working with a variety of sophisticated equipment, including computers. Sometimes this equipment doesn't work. You should anticipate the possibility that the computer systems will be "down" at *precisely* the wrong moment, and should give yourself enough extra time to accommodate equipment outages.

You should also remember to back up all of your important files. In 6.111 you will have the opportunity of keeping critical files both on sunpals and in your ATHENA locker. Do so. We will be generally unsympathetic to an excuse (for a late assignment) that involves a file being lost or erased.

Additional equipment may be obtained from the Digital Instrument Room for 12 hour throughout weekdays. During other hours some, but not all, of this equipment is available from the fifth floor instrument room.

NOTE: You must read the EECS safety policy and sign the acknowledgment form before signing out your lab kit or doing any work in the lab.

MEASURING INSTRUMENTS

In this subject, you will design, build, and test a variety of digital systems. Virtually ALL newly built digital systems of even moderate complexity do NOT work the very first

time. Even if you were to be that lucky or careful, you would still find it necessary to use some measuring instrument in order to verify the functionality of your digital system.

Many digital systems will have sound or video (TV displays) output. Even if these appear to be correct, it is still necessary to perform a careful check of subsystems. Few of us would accept an airplane simply because it flew! At the very least, we would want someone to verify that the engines are bolted on securely. Likely we would want several other checks to be made before we flew in it.

We have provided a variety of measuring instruments. In your lab kit there are LEDs which can be used to observe the state of slowly varying signals. There is also a logic probe which is convenient to carry and with which you can determine the state of slowly varying signals and even detect whether signals are pulsing or not. There has been considerable debate as to the wisdom of providing you with a logic probe. They are handy and useful in some circumstances, e.g., in your room. However, the logic probe is rarely the instrument of choice in the laboratory.

In the laboratory, we have multi-channel logic analyzers available which also include a two-channel high-speed digital oscilloscope. These measuring instruments can provide you with a substantial amount of information, which is useful for the debugging, and testing of your digital systems.

The oscilloscope displays an analog waveform and is useful for verifying that your digital signal is indeed a binary signal. If you miswire your circuit and happen to connect two outputs together, you will easily see that the resulting signal is not a logic one or zero but somewhere in between. An oscilloscope is also quite useful for measuring short time intervals.

One of the chief benefits of logic analyzers is that you have many channels available and thus you can see many signals at the same time. Logic analyzers can be used in two modes. As a timing analyzer, they are similar to an oscilloscope. However their display is quantized in both voltage level (one or zero) and in timing resolution (ten or twenty nanoseconds). When used as a state analyzer, the signals are sampled with your system clock and provide you with a compact display of many signals at the times when they really matter. This is very desirable IF your signals are indeed well behaved digital signals.

The primary purpose of the first laboratory exercise is to provide you an opportunity to learn how to use these measuring instruments and also how to program a PAL. You will then put these skills to the test in labs two and three and your final project.