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Lab 12 - Final Project

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Instrumentation Laboratory

Lab 12

Final Project

Reading: [1]

Art of Electronics Student Manual, [2]Hayes & Horowitz Pages 562 566

The Art of Electronics, [2] Horowitz & Hill Chapter 12.01-12.03, 12.06-12.07

Building An Apparatus [3]

Other References [4]

Physics 111-Lab Library Reference Site

Reprints, **all parts spec sheets,** and other information can be found on the **Physics 111 Library Site.** [5]

NOTE: You can check out and keep the portable breadboards, VB-106 or VB-108, from the 111-Lab for yourself (Only one each please)

In this last lab, you will design and build a final project of your choice. Several suggested projects are outlined, but, with the permission of the instructor, you may dream up your own project.

Final Project Proposal

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1. What is your project going to do?
2. What is your project's preliminary circuit diagram?
3. If your project will require any special components not found in lab, plese identify them.

Student Evaluation of Lab Report

After completeing the lab write up but before turning the lab report in, please fill out the **Student Evaluation of the Lab Report** [6].

Your Final Project:

You must demonstrate your completed project to the Laboratory Staff.

In this final lab, you will design and construct a project on your own. Several suggested projects are listed at the end of this write-up, but, with the permission of the instructor, you may undertake a different project. **You need to submit, with your partner, a < 2 page project proposal, due on the date specified on the course due date schedule handout.**

General Comments:

A. This lab is very different from the other labs. There may be many approaches to your goal. It is up to you to decide which approach is best. Build your project with your lab partner, and take any data together, but **your report must be written by you alone.** You may discuss the design of your experiment with any of your classmates; however, you are not allowed to copy another group's work.

B. You may use any of the breadboards and components in the Physics 111 BSC Lab. All other parts should be acquired long before you need them. The stores do not stock many special parts. You may need to buy a few specialized components. Good local sources are Al Lasher's, Radio Shack, Digikey, and Frys. Don't spend too much money; if you think you need a particularly expensive component, ask the laboratory staff. You may also call the manufacturer or look on the WEB for the **Free samples** section of the company i.e.; Texas Instruments. If you want to keep your circuit, you will need to buy a small piece of printed circuit board (PCB) with holes for ICs and connections, on which you can solder or wire wrap your circuit together (see Horowitz & Hill, chapter 12.) Note that there is a soldering station in the Lab. Note added: at the end of the course, each of you can keep one of the portable breadboards. This should help for those cases where students truly treasure their final projects.

C. Your report should be *less than 10 text pages long plus circuit diagrams not just block diagrams*.

D. The report is graded on and should consist of:

a) A title page with your name, your partner's name, the date, and a short abstract (less than 100 words) summarizing your circuit and the results of any measurements.

b) A one-page introduction. [If instructor = Reinsch, this can be as short as half a page]

c) A description of your circuit:

i) Start with a functional description: a block diagram listing all the major operations in your circuit.

ii) A readable circuit diagram.

iii) A description of the purpose and operation of all the major components in the circuit (most likely all the active components and some of the passive components.) Relate each major component to the appropriate function block.

d) Multisim circuits, if any.

e) If appropriate, a description of the theory behind your experiment.

f) A description of the experiments you performed with your circuit and the measurements you made, including your experimental methods, your raw data (in tabular or graphical form), and data and error analysis.

g) Conclusions.

h) Acknowledgments.

i) References.

Note: Complete all of the above items and you should do well.

Suggestions for building projects using LabView and electronic circuits learned:

1. **For the digitally minded: Measure the acceleration of gravity with LabView as an interface Panel.**

2. **For the analog minded: Build a circuit which transmits an audio signal over a light beam and then controlled by LabView display Panel.**

3. **Look on the Internet for ideas about your final project, but DO NOT copy the circuits. Get ideas from them, not complete diagrams. Very little of the circuits on the Internet work properly if at all and you'll waste your time trouble shooting these circuits. However, you will need some time to trouble shoot your circuits and program.**

4. **You should use LabView, ADC, DAC, and electronics you have learned in the BSC Lab.**

Suggested Project Ideas

LabView programs to take data or generate signals etc, should not be ONLY a LabView program, ie; a game or quiz or dice machine. You should have hardware as well as software components in your final project.

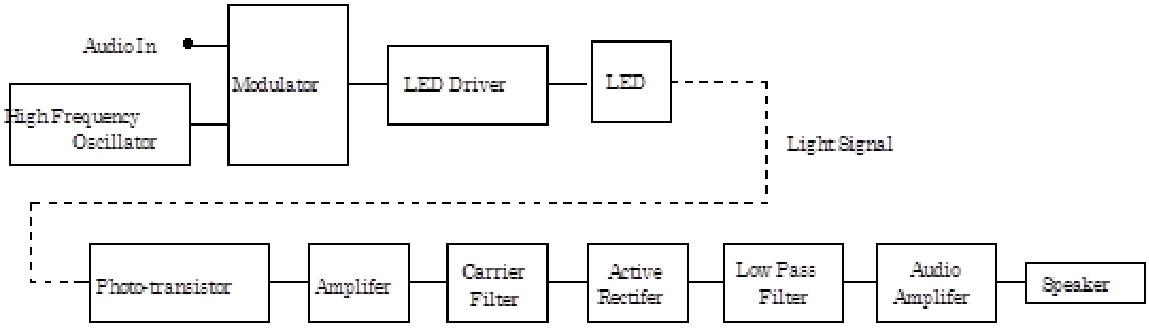
Below is a list of suggested circuit ideas. These are only suggestions and you are free to design and build anything with some exceptions. No voltages above those available on your breadboard, although higher current power supplies are negotiable. There are a lot of resources on the internet, just put some keywords into google (or your favorite) and see what is out there. See the TAs for more specific resources. When deciding on a project, try to avoid expensive or rare components. Mechanical components are the leading source of project failure and should only be used sparingly. If you build the same project as another group, you will be forced to face them in a BSC version of robot wars.

One Example:

Light Transmitter/Receiver:

Build a circuit that transmits an audio signal for a light beam. Use an LED as your light source. Detect the light signal with a phototransistor, and amplify it enough to drive a speaker.

Your circuit could be designed to modulate the light from the LED at audio frequencies, but much better results can be obtained by amplitude modulating a much higher frequency carrier signal. A possible block diagram for your project is:



Possible options are to demonstrate the simultaneous transmission of two different audio signals over the same light beam by employing two different carrier frequencies, and an automatic gain control circuit (AGC). The AGC keeps the volume of the received audio signal approximately independent of the carrier strength. Without it, the volume will decrease as the LED transmitter is moved away from the phototransistor receiver.

Acceleration of Gravity:

Use a digital timer and some phototransistor detectors to measure the acceleration due to gravity. Before beginning, make sure you thoroughly plan your experiment. Aim for an accuracy of better than 10%. If you use a ball, how far should you let it fall? If you use a timer, how accurate must it be?

Ultrasonic Sonar Velocity:
Use the Doppler shift of reflected waves to measure velocity. Measure the speed of a car, person or baseball. This can be done with a mix of analog and digital components, but is probably best done with an analog circuit and Labview interface. You could also add a feature to integrate the velocity to track a person as they walk around.

IR remote control:
Control your VCR and TV with an IR LED driven through Labview. Alternatively, and probably better for use in the regular lab area, you could also build a Labview based TV simulator that you can control with your own remote.

Color sensor:
The ratios of reflected light from red/green/yellow LEDs can be used to determine the color of an object. With Labview, you can use color swatches to train your circuit and then display the color on the screen of your display.

Metal detector:
Discriminate between Iron and Gold to find buried treasure. An exciting new career awaits you. Bermuda shorts optional.

Finger tip blood oxygen monitor:
Shine optical and IR LEDs through your finger tip and measure the attenuation of each as a function of time. It turns out the attenuation depends on the saturation of hemoglobin with oxygen in your blood, but will be different for the two wavelengths. You will see your heartbeat quite clearly in the signals from each wavelength. By measuring the absolute transmission as well as the modulation with heartbeat of each sensor, you can produce a measurement of blood oxygen saturation. It is really not as hard as it sounds and Labview

can take care of all the measurement and computation. Take it on your next Everest expedition.

Bat Detector:
Bats use ultrasonic frequencies that range from just above our range of hearing to above 200 kHz to navigate and find food. We want to downconvert the bat calls to the audio band. There are several different types of sensors and techniques that can be employed. It should be a reasonable project to build a frequency division system that retains the signal amplitude. There are some new sensors out there that will go all the way up to 200kHz. I am eager enough to see this work, that I will buy the sensor for anyone serious about it.

http://www.knowles.com/search/prods_pdf/SPM0204UD5.pdf [7]

IR Intruder Detector:
It should be possible to build a stand alone circuit that measures an intruder in a room by the change in reflected IR light. The first part would be an IR LED modulated at ~40 kHz or so to illuminate the room. You would then build a detector sensitive to the amplitude of signals at this frequency only. The amplitude of the signal would be put through a band pass filter corresponding to frequencies generated by someone moving around. With even a low power LED, this circuit should be able detect somebody many meters away.

Ultrasonic Keyfinder:
Send out a short ultrasonic chirp that is detected and used to trigger a audible reply from a separate circuit . It should be possible to get this to work over many meters.

Audio:

Whistler Receiver/Recorder: Detect the signals from Global Electrical activity. May require a field trip. Automatic ON switch.

Bat Detector/Recorder: Covert ultrasonic bat sonar to audio. Heterodyne analog or digital. Automatic on switch.

Ultrasonic Voice Transmission: Voice transmission above the range of human hearing. Transmitter Receiver/Annoy your dog! (Ask staff for Ultrasonic transmitter & Receivers)

Digital Walkie-Talkie using a laser to transmit the signal.

Digital Reverb: Delay and combine audio signals.

LED/Laser Transmission: Direct Audio Modulation/ AM transmission

Graphic Equalizer: Several bands of filters and detectors. Graphical display of power for each band using LabView.

Switches and Controls:

Ultrasonic Motion Detector: Use changes in reflected sound to detect motion.

Clapper: Two claps on/off. Add three and 4 clap sequences for multiple devices. Your neighbors will think you are insane.

Combination Lock: Push button switches must be pushed in order to open lock/ turn on light, whatever.

Telephone tone control: Use telephone tones to control remote devices. Hum a tune to unlock door.

IR remote control: Control your TV. Use you remote to turn on LEDs.

Possibly useful stuff:

Brainwave controller: control electronics or Labview with your brainwaves, etc.

Calculator: +,- , 4 bits should be enough. Extra credit for *,/

Serial Digital Data Transmission: Over Wire/Light or ultrasound.

Digital Alarm clock: Seconds/Minutes/Hours + Alarm

Automatic Phone Dialer: Push a button and dial a number. Just like your phone, but with lots of wires hanging off it.

Toys/Games:

Moth Robot: Follow Light: Turret or Car Follow dark line.

Slot Machine: Three Random number generators: Three identical numbers give jackpot/ or flashing LED.

Brainwave video game: Use the amplitude of your Brainwaves to control a LED display. May be useful in treating attention defect disorder.

Metal detector: Find Buried Treasure. An exciting new career awaits you. Bermuda shorts optional.

Radio:

Radio direction finder: Find hidden bugs, you know they are listening. Maybe not, so you will need to build a bug to test it.

Walkie Talkies: Communicate with radio waves.

Radio Control: LED, spy plane, whatever.

Test and Measurement:

Autoranging DMM: Measure millivolts to volts without turning a knob.

Capacitance meter: Use frequency of an oscillator to determine capacitance.

Frequency Counter: Digital display of audio frequencies.

Digital Thermometer: ADC and Digital Readout. Degrees K or Degrees C. Add a heater/peltier junction to make a temperature controller.

Speedometer: Digital Display of speed of rotating wheel

Ultrasonic Range finder: Digital Display of distance to objects. Could put on turret to make room mapper, but would require your own laptop.

Ultrasonic Sonar Velocity: Digital Display of the speed of moving objects. Use doppler shift of reflected waves.

Speed of sound: Ultrasonic or audio sound speed measurement.

Speed of light: Use LED or LASER to measure speed of light.

Other projects Students have completed in previous years

1. INFRARED CONTROLLED DIMMER
2. EEG/BRAINWAVE DETECTOR
3. AUDIO EQUALIZER
4. Variable BAND STEREO EQUALIZER
5. ELECTROCARDIOGRAM [EKG]:HEART ,MONITOR
6. A THEREMIN
8. A TRANSMITTING DIGITAL COMBINATION LOCK, WITH RECEIVER
9. DIRECTION SENSING MOTION DETECTOR
10. PONG ON THE OSCILLOSCOPE
11. LASER BOUNCE LISTENING DEVICE
12. LIE DETECTION VIA VARIATIONS IN SKIN RESISTANCE
13. FEEDBACK-CONTROLLED TEMPERATURE CONTROLLER [w/Labview]
14. PRECISE CALIPER USING PHASE SHIFTS OF ULTRASONIC WAVES [w/Labview]
15. DISCRETE 3 BIT OCTAL CALCULATOR
16. LINEAR ACCELERATOR
17. WIRELESS REMOTE SPEAKER
18. ARITHMETIC LOGIC UNIT
19. ANALOG CIRCUIT WHICH CONVERTS SOUND INTO LIGHT

LabView based project ideas:

1. Electronic Keyboard to musical notes into LabView Display.
2. LabView temperature controller cold or hot.
3. Color converter and recognition with digital and LabView controls
4. Feedback controller using LabView, ie; speed of motor or car
5. Laser feedback controller using LabView to lock two laser frequencies.
6. Magnet current controller using LabView and feedback.

See Professor for more details and suggestions.

Note: If Instructor = Reinsch, then your project must be less than 50% LabView (it can be 0% LabView). Your grade will not go up if you order special parts. In fact, it could go down (example: ordering a special part without explaining why you need it). Ordering special diodes, transistors and op amps is not allowed. You must use the diodes, transistors and op amps that are stocked in the lab.

While thinking about your project, you should consider if any special components will be needed to complete it. If you plan on using any parts that we do not regularly supply in the lab, you may have purchase them for yourself. Let us know what you need and we will tell you if we have anything that will work. If you need general purpose digital parts, we still have quite a stock of those and they are free. If you need to order parts, we suggest that you order any parts as soon as possible.

DO NOT BUY SURFACE MOUNT PARTS. You will not be able to use them on your breadboards or easily solder to them.

Student Evaluation of Report

After completeing the lab write up but before turning the lab report in, please fill out the **Student Evaluation of the Lab Report [8]**.

Vendors:

Marlin P Jones: http://www.mpja.com/ [9]

Lots of surplus odds and ends

All Electronics: http://www.allelectronics.com/ [10]

Lost of surplus odds and ends
Ultrasonic transducer: $1.25/each

http://www.allelectronics.com/make-a-store/item/XDR-24/ULTRASONIC-TRANSDUCER/-/1.html [11]

Small breadboards:

http://www.allelectronics.com/make-a-store/item/PB-400/SOLDERLESS-BREADBOARD-400-CONTACTS/-/1.html [12]

Electronics Goldmine: http://www.goldmine-elec-products.com/ [13]

Lots of surplus odds and ends
Ultrasonic Transducer 25kHz: 1.50$/each
http://www.goldmine-elec-products.com/prodinfo.asp?number=G951 [14]

DigiKey: http://www.digikey.com [15]

These guys have everything especially any chips that you might need, but it is not necessarily cheap.

With a little patience, you should be able to find just about anything with google. Finally, if you need it in a hurry or don't want to pay shipping, check out **Al Lashers Electronic's** at 1734 University Avenue http://www.allashers.com/ [16].

Source URL: http://instrumentationlab.berkeley.edu/Lab12

Links
[1] http://physics111.lib.berkeley.edu/Physics111/BSC/indexbsc.html
[2] http://physics111.lib.berkeley.edu/Physics111/BSC/Readings/Horowitz&Hills%20Books/indexHorowitz.html
[3] http://physics111.lib.berkeley.edu/Physics111/Reprints/Apparatus%20Book/Building-Scientific-Apparatus--Moore.pdf
[4] http://physics111.lib.berkeley.edu/Physics111/BSC/Readings/indexreadings.html
[5] http://physics111.lib.berkeley.edu/Physics111/
[6] http://instrumentationlab.berkeley.edu/StudentEvaluation
[7] http://www.knowles.com/search/prods_pdf/SPM0204UD5.pdf
[8] http://dev-physicsbsc.pantheon.berkeley.edu/StudentEvaluation
[9] http://www.mpja.com/
[10] http://www.allelectronics.com/
[11] http://www.allelectronics.com/make-a-store/item/XDR-24/ULTRASONIC-TRANSDUCER/-/1.html
[12] http://www.allelectronics.com/make-a-store/item/PB-400/SOLDERLESS-BREADBOARD-400-CONTACTS/-/1.html
[13] http://www.goldmine-elec-products.com/
[14] http://www.goldmine-elec-products.com/prodinfo.asp?number=G951
[15] http://www.digikey.com/
[16] http://www.allashers.com/