

Digital Networking

Name _____

Day 1

- Read the web article on digital networking. Answer as many questions on the worksheet as you can. (Some you may not be able to answer until later.)
- Get the Ethernet hardware from your instructor. Install it and configure your network.

Day 2

- Continue to install your Ethernet network and run the tests described in the lab sheet.

Day 3

- Finish testing your network if you did not have time yesterday.
- Remove the network cards from the computers and uninstall the network drivers.

Day 4

- In the computer lab, read the web article on "*How Routers Work*"
- Complete the lab sheet on Internet routing

Local Area Network Setup

As a group, you will set up your own 3-computer network. Get the network hardware from your instructor and follow the instructions in the network hardware setup manuals.

- After your individual computers are configured, set the IP address for each one.
 - From the Start menu, go to *Settings* → *Control Panel* → *Network*.
 - Choose the network card you just installed. When it opens, click on *Properties*.
 - Choose *Internet Protocol (TCP/IP)* from the window, then click *Properties* again.
 - Click the button marked “*Use the Following IP Address*”
 - Type in 10.0.0.1 for the first computer. The other lines you can leave blank.
 - Assign addresses 10.0.0.2 and 10.0.0.3 for the other two computers.

- Connect each of the computers to the hub.

- Check to make sure that the computers can talk to each other. From the *Start* menu, go to *Accessories* → *Command Prompt*. A window will open from which you can run commands.
 - From computer 1, type:
C:\>ping 10.0.0.2
 - This command sends 4 test signals to computer 2 and waits for replies.
 - Ping each computer from each of the other computers.

- When you can ping each computer successfully, show your network to your instructor for approval.

Instructors Initials: _____

- Set up your network to share files between computers.
 - On each computer, open My Computer
 - Right-click on drive C:
 - From the menu, choose *Sharing*
 - Select *Share This Folder* and close the window. A blue hand will appear on the drive.

- When you can share files, test your network speed. Copy a large file from one computer to another. Time how long it takes to transfer. Calculate the network speed in kilobytes per second.

	File Size	Time	kB/sec
Computer 1 to Computer 2	_____	_____	_____
Computer 1 to Computer 3	_____	_____	_____
Computer 2 to Computer 3	_____	_____	_____

Ethernet is supposed to be able to transfer 12 MB per second. Does your network reach this speed? _____

- Have your instructor sign off after you have disassembled your network.

Instructors initials: _____

Internet Routing Lab Sheet

Read the "How Routers Work" article. You can stop when you reach the "Tracing a Message" section. If you have time, you may also watch the "Warriors of the Net" video.

1. Summarize what happens when you request information, like a web page, from another computer. How does it get to your computer?

You will use a program called NeoTrace Express to trace traffic on the Internet. Go to Start → NeoTrace Express → NTX. NeoTrace gives you a route map and router list from your computer to any web address that you enter.

2. Trace www.google.com. Fill in the information below:

<i>Geographic location</i>	<i># of hops</i>	<i>Route Time</i>	<i>Major router cities</i>
_____	_____	_____	_____

3. Numbers beginning with 10 . ~ . ~ . ~ are routers on the ISU internal network. How many routers do you go through here at ISU before getting on the Internet? _____

4. Address 192.168.0.1 appears in all the routes that you will trace. Figure out what it is and explain here. (*Hint: go back to the LAN sketch that you made on day 1.*)

5. Find a web site in each of the following places, and trace the network path to get there. For credit, you must find different sites than any other person in class.

<i>Place</i>	<i>Site</i>	<i>Route Time</i>	<i>Major Router Points</i>
Europe	_____	_____	_____
China	_____	_____	_____
S. America	_____	_____	_____
Australia	_____	_____	_____
Africa	_____	_____	_____

(If you have time, find more locations for extra credit)

6. Trace the site www.dot.tk. This is the site for the island of Tokelau. Where is Tokelau? Where is its web site? Explain why you think the site is set up this way.

Analog Audio Project

Day 1

- Read the handout on audio principles and answer the questions on the worksheet. The worksheet will be collected and graded at the end of the unit, so hold on to it.

Day 2

- Build an audio speaker by following the instructions on the next page. Experiment with the speaker and fill in the questions on the lab sheet.
- If you have extra time, you can make other changes to the speaker for extra credit. Record your experiments & results on an extra sheet of paper.

Day 3

- Complete the speaker activity if you did not finish yesterday.
- Begin to build your telephone system by following the instructions.

Day 4

- Complete your telephone system.
- Conduct the experiments on the system that are described on the project sheet.
- Show your instructor the finished telephone system, then take it apart.

Basics of Sound and Sound Systems Worksheet

Name _____

Read the handout “Basics of Sound and Sound Systems” and then complete this worksheet.

1. What is sound? (in your own words)

2. Define *frequency* and *wavelength*:

frequency:

wavelength:

3. A dog whistle is a special whistle that dogs can hear, but humans cannot. Explain how this works.

4. Based on the decibel chart in the article, estimate the decibel level of the loudest sound that you hear regularly.

Sound: _____ Estimated decibel level: _____ dB

According to the chart, is this sound level loud enough to cause ear damage?

5. What is a transducer?

6. List three examples of transducers and explain what type of signal they input and output:

7. What is a signal processor?

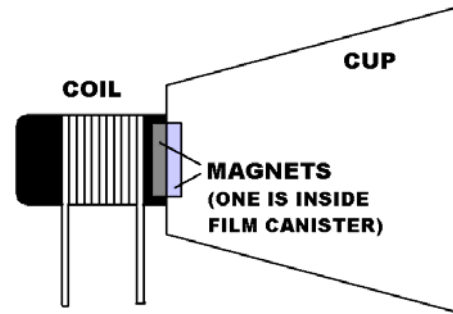
Constructing a Speaker

Name _____

1. Build the coil for your speaker by wrapping magnet wire around the outside of a film canister. The wire should be wrapped to make a neat row of wires lying next to each other, not on top of each other. (See picture). Make your coil about 1 inch long. Tape the wire to the film canister so the wire doesn't unravel.

2. Make the cone for your speaker by placing two magnets on the bottom of a plastic cup. Place one magnet on the inside and one on the outside so that they stick together and hold each other onto the cup.

3. With a small piece of sandpaper, sand the ends of the magnet wire to remove the insulation. Connect the ends of the wire to the frequency generator. Set the frequency to about 1 kHz (1000 Hz)



4. Press the film canister / coil firmly over the magnet on the end of the cup. Put the cup up to your ear. You should hear the tone from the frequency generator.

Lab Worksheet

1. Explain how this speaker works.

2. Change the sound frequency – make it higher and lower until you can no longer hear it. What are the lowest and highest frequencies that your speaker can produce?

3. How can you make a better quality speaker? There are extra magnets and wire available, as well as different materials for the cone. Try at least two changes and record here what effect they have on volume, frequency range, or clarity:

Effect on:
Change _____ Volume _____ Frequency Range _____ Clarity _____

4. Show your best performing speaker to your instructor for approval. (One for each person)

Instructor's initials: _____

Building a Telephone

1. A telephone is basically a device that carries sound from one person to another over wires. At each end, the telephone needs to do two things: pick up sound, and play it back. Using this description, sketch a schematic of two basic devices, connected by wires, which could act like telephones. Be sure to show all parts and all wires.

Telephone 1

Telephone 2

2. *Your instructor will give you the equipment that you included in your schematic above. Working in pairs, build your telephone according to the schematic you drew. Each pair should build one telephone. Does your phone work? If so, how well? If not, why?*
3. Your instructor will provide two other devices to put into your circuit. Figure out how to connect them, but do not change your schematic in question 1. What are these devices and why do they improve the performance of the telephone?
4. Demonstrate your completed telephone to your instructor for approval.

Instructor's initials: _____
5. Choose any one of the following items to test on your telephone. Put your answers and sketches on a separate sheet of paper.
 - a. You probably used four wires between telephones. Try to hook up your phones using only two wires that carry sound both ways. What difference does this make in performance?
 - b. Hook up a third telephone to the system. Test, then sketch a schematic of a working system.
 - c. Add a hang-up switch to each telephone.
 - d. Sketch a schematic of a central unit that allows one telephone to connect to any other one telephone (like what happens when we dial another phone number.)

Digital Audio Project

Day 1

- Read the web articles on digital audio recording and answer the questions on the worksheet.
- If you have time, begin the lab sheet on digital audio.

Day 2

- Complete the lab sheet on digital audio. If you finish, begin the music and effects lab sheet.

Day 3

- Complete the music and effects lab sheet.

Day 4

- *Goldwave* can also be used to mix and edit audio tracks. Use the help file and experiment with the program to cut, edit, and mix audio.
- There are a number of sample audio files on the computer. Load some of these. Edit and mix to create a new track of your own design – make it as interesting as you like.
- Save the sound file with your name to the Intro to Tech network folder.

Digital Audio Principles

Name _____

Open the two web articles “How Analog and Digital Recording Works” and “How CDs Work”. The articles will make more sense if you read the recording article first, then the CD article.

1. What is the main difference between analog and digital waves?
2. Sampling rate is one of the two things affecting the quality of a digital wave. What is the other one, and how does it affect quality?
3. How does a CD store all the information in a digital wave? How is it turned into sound?
4. Does a CD contain “perfect audio”? Why or why not?
5. Explain how an MP3 player stores and plays back digital sounds.

Digital Audio Lab Sheet

Name _____

Load the *Goldwave* program on a computer that has headphones attached to it. Open the file named "440" You should see a window with a sound wave. Pressing the **▶ Play** button will play the sound wave that is highlighted.

1. Zoom in to see the individual waves by pressing the button marked **1:1**. Sketch what you see. Then, zoom in more by pressing **Shift+Up Arrow** a few times. You should see new details in the shape of the wave. Sketch a closeup of the wave.

Wave at 1:1

Closeup

2. Your instructor will give you two digital waves to analyze. Go to File→Open. Your instructor will tell you which files to use. Open up these files.. Zoom in to see the steps visible in each wave, and then fill in the chart below:

	Wave ____	Wave ____
Count the number of steps in one full wave <i>(full wave = top of one wave to top of the next)</i>		
Frequency (number of waves in 1 second) <i>(use the time graph at the bottom of the screen)</i>		
What is the sample rate of this wave? <i>(sampling rate = steps per second)</i>		
Choose which wave is higher-quality digital audio:		

3. Use the Resample tool (go to Effects→Resample) to reduce the sample rate of Wave A. Reduce it to 16000, then 8000, 4000, 2000, and 1000. At what sample rate does it stop looking like a sine wave?
4. Sketch what one wave looks like at this sample rate:

5. Open the file named “Resample Test”. Use the resample tool to decrease the sampling rate down to 16000, then 8000, etc. In your opinion, what is the minimum sampling rate that can be used and still have acceptable sound quality? What happens to the sound below this sampling rate?

6. A CD has 44,100 samples per second. A computer WAV files usually has 11,000 samples per second, while a digital answering machine has about 5,000. If higher sample rates have better sound quality, why do we sometimes use a lower sampling rate?
(Hint: look at the file properties of two waves you analyzed.)

7. Some audio experts still prefer analog audio (records) over digital audio (CDs). What is the best technical reason for their claim that analog audio is better?
(Hint: what does an original sound wave look like before it is recorded?)

8. There are also advantages to digital audio over analog audio. List at least 3 here:

Music and Effects Lab Sheet

Name _____

In the previous lab, changing the shape of the wave usually sounded bad. However, audio editors can change the shape of waves in good ways – to add effects or improve the sound. Editors can also cut, copy, and mix sounds easily. You will look at these techniques in this lab.

Open the file “Echo Test” and play it. Zoom out so you can see the whole sound.

1. Go to Effects→Echo. Set the echo settings to 4 echoes, delay of 0.5 seconds. Sketch the original wave and the new wave here:

original

with echo

2. Based on the wave shape, explain how the computer creates an echo.

The computer can also add reverb to a sound. Reverb is a complex echo effect that simulates the sound bouncing around a large room.

3. Undo the echo effect, then go to Effects→Reverb. Experiment with the reverb settings until it sounds like the sound is being heard in a large concert hall. Record your settings here:

Open the file “Noise Test” and play it. Notice that this sound has an annoying low-frequency hum. The computer can digitally remove this hum by creating a filter that subtracts certain frequencies from the wave.

4. Go to Effects→Filters→Low/Highpass. Experiment with the settings in the box until you find a filter that removes the hum but leaves the main sound the same. Record your settings here:

5. Experiment with the other tools in the Effects menu in Goldwave. Explain below what at least three of them do.

Wireless Communication Project

Day 1

- Begin the Laser Communication lab sheet

Day 2

- Finish the Laser Communication lab sheet.
- If you have time, begin the Radio Transmitter lab sheet.

Day 3

- Finish the Radio Transmitter lab sheet
- Start the Radio Transmission worksheet

Day 4

- Complete the Radio Transmission worksheet
- If time, you may try to build an AM receiver for extra credit (talk to your instructor)

Laser Communication Lab Sheet

Name _____

You will start with the receiving end of the laser communicator – a solar cell.

1. Use a voltmeter to record the voltage produced by the solar cell under the conditions below.

In darkness (covered up)	_____ V
In room light:	_____ V
Laser pointer shining on solar cell	_____ V

2. Why is the voltage different in these three situations?

Connect the solar cell to the amplifier. The amplifier will turn voltage changes in the solar cell into sound. Turn up the amplifier to medium-high volume. Compare the noise that you hear when you hold the solar cell up to an AC-powered light and a DC-powered light. (A classroom light and a flashlight will work fine.)

3. Why does the AC-powered light create noise like this? Why doesn't the DC light make noise?

Disassemble the laser pointer. Have your instructor help you set up the frequency generator to the inputs of laser. Clip the black lead to the spring inside the laser pointer. Clip the red lead to the laser pointer case. Turn on the laser pointer.

4. Set the frequency generator to make a 1 Hz sine wave. Shine the beam at the solar cell. What do you see and hear?

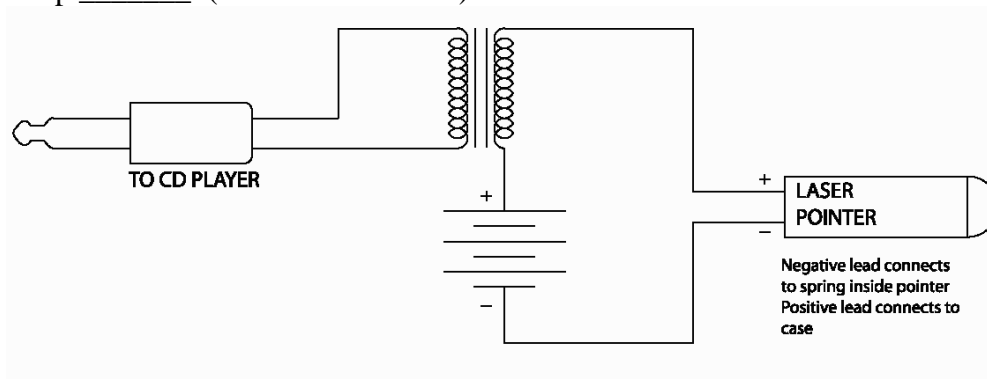
5. Increase the frequency to 10 Hz, then 100 Hz, then 1000 Hz. What do you see and hear?

6. Why does the laser get brighter and dimmer?

7. Why does the amplifier produce sound?

Assemble your laser transmitter by following the schematic below. Have your instructor check your setup before going on.

8. Correct setup _____ (instructor's initials)



Note: The CD player outputs a very small AC voltage. The transformer increases the CD player voltage to about -1 V to $+1\text{ V}$ AC. The battery pack supplies 4.5 V DC to the laser.

9. Based on the information above, what is the maximum and minimum voltage that will be supplied to the laser?

Turn the CD volume up about halfway. Point the laser at the solar cell. (It helps to have the solar cell shielded from the room lights by a piece of cardboard.)

10. Experiment to find the maximum range of the laser transmitter. What is it?

11. Below, explain how the laser communicator works as if you were talking to someone with very little technical knowledge. Be sure to explain what each of the major components does.

Radio Transmitter Lab Sheet

Name _____

1. The laser communicator had some disadvantages for long-range communication. Explain at least two of them:

Light is a form of electromagnetic radiation. Other forms of electromagnetic radiation include microwaves, x-rays, and radio waves. In this lab, you will use radio waves to transmit sound.

2. Do radio waves solve any of the disadvantages that you listed in question 1? Explain.

Use the same schematic as you did for the laser transmitter, except connect the red and black leads to the red and black jacks of the oscillator instead of the laser pointer. The oscillator produces a 1 megahertz (MHz) sine wave. A high-frequency wave like this is needed to carry the signal through the air. Lower-frequency waves do not travel as well.

3. AM radios are tuned in kilohertz (kHz.) To listen to this oscillator on an AM radio, what frequency should be tuned in?

4. The laser communicator varied the brightness of the laser to transmit sound. What is being varied in this setup? *(Your instructor may set up an oscilloscope if you need more information.)*

Connect an antenna to pin 4 of the oscillator. Turn on the CD player and radio.

5. Carry the radio to different parts of the room. What is the range of your transmitter?
6. Try placing different materials (wood, steel, plastic, etc.) between the transmitter and receiver. What materials affect the signal the most?
7. Add a longer antenna wire to the transmitter. Explain, with details, how this affects signal strength and range.

Radio Transmission Worksheet

Name _____

On the computer, read the article on *How Radio Works*. Answer the questions below.

1. Why are spark-coil transmitters not allowed these days?
2. There are thousands of radio signals in the air at any time. How are they kept separate?
3. Look at the diagram with the voltmeter, compass, switch, and battery. Notice that the voltmeter is not connected to the battery. Why does it show voltage?
4. How did you modulate the signal in the transmitter that you built? (*Hint: see #4 on previous page.*)
5. Sketch a wave for that type of modulation.
6. Assume that you wanted to build a wireless Morse code communicator that would send signals a few feet. Design a schematic for both the transmitter and receiver and draw them below.
7. What type of modulation does this use?

Grading Sheet

Communications Projects

Name _____

Analog Audio

<i>Assignment</i>	<i>Possible</i>	<i>Score</i>
Sound basics worksheet	7	_____
Speaker construction	8	_____
Telephone construction (demonstrate)	5	_____
Telephone lab sheet	10	_____
Extra credit / penalties	<u>0</u>	_____
Total	30	_____

Digital Audio

<i>Assignment</i>	<i>Possible</i>	<i>Score</i>
Digital audio principles	7	_____
Digital audio lab sheet	10	_____
Music effects lab sheet	8	_____
Mixed audio file	5	_____
Extra credit / penalties	<u>0</u>	_____
Total	30	_____

Wireless Communication

<i>Assignment</i>	<i>Possible</i>	<i>Score</i>
Laser communication	14	_____
AM transmitter	8	_____
Radio worksheet	8	_____
Extra credit / penalties	<u>0</u>	_____
Total	30	_____

Digital Networking

<i>Assignment</i>	<i>Possible</i>	<i>Score</i>
LAN lab sheet	10	_____
LAN setup, testing, and disassembly	10	_____
Internet routing lab sheet	10	_____
Extra credit / penalties	<u>0</u>	_____
Total	30	_____