Assignment #1

COBI misweb Student Information System

If you have used the misweb system in the past, you must still access your Edit Routine for completion of this assignment. On your Student Profile Page, the bottom line indicates “Last updated:”, followed by a date and time. This date and time must indicate that you have accessed your Edit Routine specifically for this class, this semester. If the date and time indicate that your Student Profile Page was last edited prior to the beginning of this semester, you will not get credit for this assignment.

Be sure to also check your grades specifically for this assignment. Like your “Last updated:” date and time, a time stamp is recorded when you check your grades. Be sure to check your grades specifically for this assignment, even if you have checked them in the past.

Each COBI student has the opportunity to maintain a student profile page as part of the COBI misweb web site. This system uses the misweb as a central starting point that any student, faculty member, prospective employer, or other interested party can use to contact you.

Register for the COBI misweb Student Information System

To register for misweb, use your web browser to go to the URL:

http://misweb.cbi.msstate.edu/editor

[You will use this URL in the future to access the Edit Routine to edit your own data, such as to change your preferred email address, your local address, etc.]

Enter your MSU Banner net id and net password in the textfields and click the Log in button.

If things go well, you will see a form that has several input fields. Enter any information that is needed to complete all fields. Please try to type correctly!

Click the Continue button. That’s all there is to it! You are now registered for the misweb system. You can edit your own data for your personal student profile page, keeping it up to date throughout your college career.
Once you have completed this registration process, you will have an account in the COBI misweb Student Information System. Your account is password-protected. NOTE: If you do not want to use your Banner net password when you access misweb, you have the option of creating an additional special misweb-only password. Use the option in your misweb Edit Routine to create your misweb-only password.

To edit your information in this system, go to the URL shown earlier and log in, using your MSU net id and net password. You will then see the Edit Routine, which shows the different sections of data that you can edit.

To access misweb, go to the following URL:

http://misweb.cbi.msstate.edu

If you have any questions about this system, please email:

rodney.pearson@msstate.edu

Checking your misweb online grades

To check your grades, go to the main misweb page, at:

http://misweb.cbi.msstate.edu

Go to your teacher's faculty profile page. Scroll down to the Courses Taught section. Click on any link for Online Grades.

On the next screen, select your class from the list of Online Gradebooks, enter your net id and password in the textfields, and click the Log in button.

Assuming that you log in correctly, you will see one or more buttons for your class. These buttons (if available) link to:
- your grades
- the private course web site
- an online class calendar
- the class email archive
- the class message board

The button page also has a link at the very top that you can use to log out of misweb. For (your own) security reasons, you should always log out rather than just moving to a different web page, since logging out physically terminates your misweb session.
For your homework assignment, you must do the following:

1. Register for misweb.
2. Enter your basic information, such as name, local address, email address, and phone number.

   Access your edit routine and be absolutely sure that you have a valid email address entered into your misweb account. Go to your student profile page, and click on your email link to send yourself a message from your page.

   **Be sure that your email link works!**

3. Enter your academic history information, including high school.
4. Enter any work experience that you have.
5. Either upload an image of your own or select an image from the COBI gallery.

   For the purposes of this assignment, you must put an image on your student profile page. You can either upload your own image, or use one from the COBI gallery.

6. Check your grades in this class. To check your grades, go to the main misweb page, at:

   [http://misweb.cbi.msstate.edu](http://misweb.cbi.msstate.edu)

   Go to your teacher's faculty profile page. Scroll down to the Courses Taught section. Click on the link for Online Grades.

7. While you are checking your grades, familiarize yourself with the available buttons, such as Private Course Web Site, Class Calendar, EMail Archive, and Class Message Board.

8. Post a message on the Class Message Board under the Topic: Important events in the history of computing

   If the Topic has not been created yet, create it. If it has been created, add your message to the Topic. Try to add something meaningful.

   Pay attention to what you are doing when you post a message on the Class Message Board. If the Topic already exists, **DO NOT CREATE A NEW TOPIC**. Instead, add a message to the existing Topic.

   To add a message to an existing topic, you must actually read at least one existing message on the topic. When you read a message, you will see a button to Post a New Message.
9. Go to the Private Course Web Site and follow the link to Homework #1. Submit your online Homework Review form for this assignment. This form is not graded per se, but is more of a checklist. Your actual answers on the form do not matter; but you must submit your form.

You have an Online Assignment due each Friday night at 11:00pm.

You also have an Online Quiz due each Friday night at 11:00pm.

Each of these items will be graded for a homework grade.
Caching

Be sure to read this page. It describes a problem that confuses many web users.

If you ever access a web page, and it seems like you are getting an old copy of the page, your web browser may be giving you a copy of that page from its cache. In general, a cache is a temporary holding place. When you access a web page, your browser can store the page in its cache; then if you ask for the page again, the browser can give you the copy from its cache rather than going back to the internet for the page. If the page has not changed, the copy from cache is just fine. But if the page HAS changed, you have a problem.

In this assignment, if you edit your student profile data, then go look at your student profile page and the "date of last update" has not changed (and the edited data has not changed either), then it is almost certain that your browser is giving you a copy of the page from its cache. You can normally force the browser to give you a new copy by holding down the shift key, and clicking on the Refresh (or Reload) button.

You can configure your browser's caching. In Navigator, click on Edit, Preferences, Advanced, Cache. If you are using a high-speed connection, you probably want to click on "Every time I view the page". If you are using a dial-up connection, you might prefer "Once per session".

In Internet Explorer, click on Tools, Internet Options, General, Settings.

As a web professional, always remember that browsers may be configured differently, so something that works one way on one computer may work a different way on a different computer. Caching is one of those things that can be configured differently, and it can really confuse the inexperienced user.
Assignment #2

In this class, you are encouraged to work on your homework assignments in a group of good students. More importantly, you are encouraged to **be a good group member!** Help each other. Ask each other for help. Use your group membership as a learning experience, to help yourself learn more, and to help your group members learn more.

Read this assignment, and do all of the work on the assignment. When you finish, go to the Private Course Web Site and follow the link to the Online Assignment. Your Online Assignment is due at 11:00pm Friday.

**Binary, Decimal, Hexadecimal, and RGB Values**

**Introduction**

Three different number systems are commonly used in various areas of computing:

1. the binary number system -- this system has only two digits: 0 and 1
2. the decimal number system, which has nine digits: 0,1,2,3,4,5,6,7,8,9
3. the hexadecimal number system, which has 16 digits: 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F

For example, we usually specify a color with a 6-digit hexadecimal RGB (Red, Green, Blue) value, such as:

```html
<body bgcolor='#F43A6C'>
```

The # prefix is used in many programming languages to indicate that this is a hexadecimal (Base 16) number. In reality, when you get down to the low level, all values in computers are represented in binary. We use hexadecimal only at the high level, because converting from binary to hexadecimal is quite easy, even with long numbers.

If you are going to be working with color codes, you will be using hexadecimal numbers. If you are going to be using hexadecimal numbers, it is useful to understand them.

There are (theoretically) an infinite number of number systems, including binary (Base 2), octal (Base 8), decimal (Base 10), hexadecimal (Base 16), and many, many more. A number system is defined by the *number of digits* in the number system. Base 2 has two possible digits (0,1); Base 8 has eight possible digits (0,1,2,3,4,5,6,7); Base 10 has ten possible digits (0,1,2,3,4,5,6,7,8,9); Base 16 has sixteen possible digits (0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F).

Each of these number systems is a *positional number system* (these are all Hindu-Arabic number systems, if I remember correctly) – the position of a digit defines its *value*. In any Base, the value of each position is expressed as a *power of the Base*:

\[
\begin{array}{cccccccc}
b^7 & b^6 & b^5 & b^4 & b^3 & b^2 & b^1 & b^0 \\
\end{array}
\]
With a decimal number, the values of the positions are:

<table>
<thead>
<tr>
<th>10⁷</th>
<th>10⁶</th>
<th>10⁵</th>
<th>10⁴</th>
<th>10³</th>
<th>10²</th>
<th>10¹</th>
<th>10⁰</th>
</tr>
</thead>
<tbody>
<tr>
<td>10,000,000</td>
<td>1,000,000</td>
<td>100,000</td>
<td>10,000</td>
<td>1000</td>
<td>100</td>
<td>10</td>
<td>1</td>
</tr>
</tbody>
</table>

With a binary number, the values of the positions are:

<table>
<thead>
<tr>
<th>2⁷</th>
<th>2⁶</th>
<th>2⁵</th>
<th>2⁴</th>
<th>2³</th>
<th>2²</th>
<th>2¹</th>
<th>2⁰</th>
</tr>
</thead>
<tbody>
<tr>
<td>128</td>
<td>64</td>
<td>32</td>
<td>16</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

**Converting from Binary to Decimal**

Consider the Binary value 10011010. Consider the value of each digit in the number.

<table>
<thead>
<tr>
<th>10011010</th>
<th>1</th>
<th>0</th>
<th>0</th>
<th>1</th>
<th>1</th>
<th>0</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>positional value</td>
<td>128</td>
<td>64</td>
<td>32</td>
<td>16</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

To convert 10011010 Binary to an equivalent Decimal value:

128 + 16 + 8 + 2 = 154 Decimal

Complete the following table to show the decimal equivalent of each of the binary values.

<table>
<thead>
<tr>
<th>Binary value</th>
<th>Decimal value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1001</td>
<td></td>
</tr>
<tr>
<td>10100111</td>
<td></td>
</tr>
<tr>
<td>0111</td>
<td></td>
</tr>
<tr>
<td>11111111</td>
<td></td>
</tr>
<tr>
<td>1001101001010110</td>
<td></td>
</tr>
</tbody>
</table>
Converting from Decimal to Binary

To convert a decimal value into its binary equivalent, repeatedly divide the decimal value by 2, taking the remainder each time you divide. Consider the following few examples.

What is the binary equivalent of the decimal value 9?

\[
\begin{array}{c|c}
2 & 9 \\
2 & 4 \quad r 1 \\
2 & 2 \quad r 0 \\
2 & 1 \quad r 0 \\
0 & r 1 \\
\end{array}
\]

9 divided by 2 4 divided by 2 2 divided by 2 1 divided by 2

Starting with the last remainder, and working up the list, the binary value equivalent is 1001.

What is the binary equivalent of the decimal value 100?

\[
\begin{array}{c|c}
2 & 100 \\
2 & 50 \quad r 0 \\
2 & 25 \quad r 0 \\
2 & 12 \quad r 1 \\
2 & 6 \quad r 0 \\
2 & 3 \quad r 0 \\
2 & 1 \quad r 1 \\
0 & r 1 \\
\end{array}
\]

100 decimal equals 1100100 binary. (To check your conversion, you could convert the binary value back to decimal to make sure that you get 100.)

<table>
<thead>
<tr>
<th>1100110</th>
<th>1</th>
<th>1</th>
<th>0</th>
<th>0</th>
<th>1</th>
<th>0</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>positional value</td>
<td>64</td>
<td>32</td>
<td>16</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

To convert 10011010 Binary to an equivalent Decimal value:

\[64 + 32 + 4 = 100 \text{ Decimal}\]
Complete the following table to show the binary equivalent of each of the decimal values.

<table>
<thead>
<tr>
<th>Binary value</th>
<th>Decimal value</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>167</td>
</tr>
<tr>
<td>7</td>
<td>255</td>
</tr>
<tr>
<td>39,580</td>
<td></td>
</tr>
</tbody>
</table>

**Comparing Decimal and Hexadecimal**

While it is certainly possible to convert any Decimal value to Hexadecimal, we don’t really need to, so we won’t cover it here. We just need to be able to count to 15 (Decimal, which is F Hexadecimal):

<table>
<thead>
<tr>
<th>Decimal</th>
<th>Hexadecimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>A</td>
</tr>
<tr>
<td>11</td>
<td>B</td>
</tr>
<tr>
<td>12</td>
<td>C</td>
</tr>
<tr>
<td>13</td>
<td>D</td>
</tr>
<tr>
<td>14</td>
<td>E</td>
</tr>
<tr>
<td>15</td>
<td>F</td>
</tr>
</tbody>
</table>
Converting Binary to Hexadecimal

Converting Binary to Hexadecimal is easy, no matter how long the Binary value is. This is because “four binary digits equals one hexadecimal digits”. How many different values can you represent with four binary digits? Sixteen. How many different values can you represent with one hexadecimal digit? Sixteen.

To convert from Binary to Hexadecimal, start at the right end of the Binary number (at the Binary point), and group the digits into sets of four binary digits (bits). Consider the Binary number 111101000011101001101100 (wow, that’s a long number!)

Starting from the binary point, group the binary digits into sets of four digits:

```
  1111 0100 0011 1010 0110 1100
```

Now convert each set (of four digits) into an equivalent Decimal value:

```
  15  4  3  10  6  12
```

Finally, convert the Decimal equivalents into Hexadecimal:

```
    F  4  3  A  6  C
```

111101000011101001101100 Binary equals F43A6C Hexadecimal. Note that this Hexadecimal value is the sample RGB value that was used at the beginning of this document.

We use Hexadecimal values (frequently called Hex values) in specifying RGB values because converting from Binary to Hexadecimal is much easier than converting Binary to Decimal. The 24 bits of an RGB color convert to 6 Hex digits.

Complete the following table to show the hexadecimal equivalent of each of the binary values.

<table>
<thead>
<tr>
<th>Binary value</th>
<th>Hexadecimal value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1001</td>
<td></td>
</tr>
<tr>
<td>10100111</td>
<td></td>
</tr>
<tr>
<td>0111</td>
<td></td>
</tr>
<tr>
<td>11111111</td>
<td></td>
</tr>
<tr>
<td>1001101001010110</td>
<td></td>
</tr>
</tbody>
</table>
Converting Hexadecimal to Binary

Converting Hexadecimal to Binary is easy, no matter what size number you consider. Each Hex digits converts to four binary digits. Consider the hex value:

F 4 3 A 6 C

First, convert each Hex digit into Decimal:

15 4 3 10 6 12

and now, into Binary:

1111 0100 0011 1010 0110 1100

Thus, the 6-digit Hex value F43A6C equals 111101000011101001101100 Binary.

Complete the following table to show the binary equivalent of each of the hexadecimal values.

<table>
<thead>
<tr>
<th>Binary value</th>
<th>Hexadecimal value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>A7</td>
</tr>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>FF</td>
</tr>
<tr>
<td></td>
<td>9A56</td>
</tr>
</tbody>
</table>
Converting from Hexadecimal to Decimal

While we rarely need to convert a Hexadecimal value into Decimal, we sometimes do when we are working with RGB values (many image-editing programs use Decimal RGB values, so we may need to convert a Hex RGB value that we know into Decimal for that particular program). Fortunately, we need to work with only two-digit Hex values, so the conversion is easy. As always, consider the value of the position of each digit.

<table>
<thead>
<tr>
<th>positional value</th>
<th>$16^1$</th>
<th>$16^0$</th>
<th>conversion</th>
<th>Decimal value</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hex value</td>
<td>conversion</td>
<td>Decimal value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00</td>
<td>0</td>
<td>0</td>
<td>$0\times16 + 0\times1$</td>
<td>0</td>
</tr>
<tr>
<td>80</td>
<td>8</td>
<td>0</td>
<td>$8\times16 + 0\times1$</td>
<td>128</td>
</tr>
<tr>
<td>A5</td>
<td>A</td>
<td>5</td>
<td>$10\times16 + 5\times1$</td>
<td>165</td>
</tr>
<tr>
<td>CD</td>
<td>C</td>
<td>D</td>
<td>$12\times16 + 13\times1$</td>
<td>205</td>
</tr>
<tr>
<td>FF</td>
<td>F</td>
<td>F</td>
<td>$15\times16 + 15\times1$</td>
<td>255</td>
</tr>
</tbody>
</table>

Complete the following table to show the decimal equivalent of each of the hexadecimal values.

<table>
<thead>
<tr>
<th>Decimal value</th>
<th>Hexadecimal value</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>A7</td>
</tr>
<tr>
<td>7</td>
<td>FF</td>
</tr>
</tbody>
</table>
Converting from Decimal to Hexadecimal

Just as in the previous case, we sometimes need to convert a Decimal RGB value that a program gives us into a Hex value for another program. In this case, we know that we can limit ourselves to the range of 0-255 Decimal (0-FF Hexadecimal, or 00000000-11111111 Binary). Why is this? (Because we use 8 bits to represent each color.)

To convert a Decimal value to a 2-digit Hex number, see how many 16's, and how many 1's are in the Decimal value. Consider the following examples:

<table>
<thead>
<tr>
<th>Decimal value</th>
<th>16's</th>
<th>1's</th>
<th>Hexadecimal value</th>
<th>Binary value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>00</td>
<td>0000 0000</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>10</td>
<td>0A</td>
<td>0000 1010</td>
</tr>
<tr>
<td>131</td>
<td>8</td>
<td>3</td>
<td>83</td>
<td>1000 0011</td>
</tr>
<tr>
<td>201</td>
<td>12</td>
<td>9</td>
<td>A9</td>
<td>1100 1001</td>
</tr>
<tr>
<td>255</td>
<td>15</td>
<td>15</td>
<td>FF</td>
<td>1111 1111</td>
</tr>
</tbody>
</table>

Complete the following table to show the hexadecimal equivalent of each of the decimal values.

<table>
<thead>
<tr>
<th>Decimal value</th>
<th>Hexadecimal value</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>167</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>255</td>
<td></td>
</tr>
</tbody>
</table>
RGB Values

In a 24-bit RGB value, the first eight bits of the value represent the intensity of Red; the next eight bits represent the intensity of Green; and the final eight bits represent the intensity of Blue. Using eight bits to represent the intensity of Red, you can represent $2^8$ (256) different shades of Red. You can also represent $2^8$ different shades of Green, and $2^8$ different shades of Blue. Considering the entire 24-bit value, you can represent $2^{24}$ (16,777,216) different colors.

Here are a few common colors:

<table>
<thead>
<tr>
<th>Color</th>
<th>Binary</th>
<th>Hexadecimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>11111111 00000000 00000000</td>
<td>FF 00 00</td>
</tr>
<tr>
<td>Green</td>
<td>00000000 11111111 00000000</td>
<td>00 FF 00</td>
</tr>
<tr>
<td>Blue</td>
<td>00000000 00000000 11111111</td>
<td>00 00 FF</td>
</tr>
<tr>
<td>Black</td>
<td>00000000 00000000 00000000</td>
<td>00 00 00</td>
</tr>
<tr>
<td>White</td>
<td>11111111 11111111 11111111</td>
<td>FF FF FF</td>
</tr>
<tr>
<td>Very dark gray</td>
<td>00001111 00001111 00001111</td>
<td>0F 0F 0F</td>
</tr>
<tr>
<td>Medium gray</td>
<td>10000000 10000000 10000000</td>
<td>80 80 80</td>
</tr>
<tr>
<td>Light gray</td>
<td>11110000 11110000 11110000</td>
<td>F0 F0 F0</td>
</tr>
</tbody>
</table>

(Note: equal shades of Red, Green, and Blue will give you some shade of Gray. Low RGB values, such as 0F0F0F, represent darker shades of Gray. Higher RGB values, such as F0F0F0, represent lighter shades of Gray.)

Combinations

In computing, numeric values are used to represent different items. In 24-bit RGB color, for instance, 8 bits are used to represent the intensity of Red. We frequently need to know how many different combinations can be represented with a specific numeric value. The rather simple formula is:

The formula to calculate the number of combinations that can be represented with a numeric value is:

$$b^n$$

where: $b$ is the base of the number, and $n$ is the number of digits in the number.
Consider the following examples:

<table>
<thead>
<tr>
<th>Numeric value</th>
<th>Formula</th>
<th>Number of combinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 binary digit (bit)</td>
<td>$2^1$</td>
<td>2</td>
</tr>
<tr>
<td>4 binary digits</td>
<td>$2^4$</td>
<td>16</td>
</tr>
<tr>
<td>1 hexadecimal digit</td>
<td>$16^1$</td>
<td>16</td>
</tr>
<tr>
<td>8 binary digits</td>
<td>$2^8$</td>
<td>256</td>
</tr>
<tr>
<td>2 hexadecimal digits</td>
<td>$16^2$</td>
<td>256</td>
</tr>
<tr>
<td>10 binary digits</td>
<td>$2^{10}$</td>
<td>1,024 (aka 1K)</td>
</tr>
<tr>
<td>16 binary digits</td>
<td>$2^{16}$</td>
<td>65,536 (aka 64K)</td>
</tr>
<tr>
<td>4 hexadecimal digits</td>
<td>$16^4$</td>
<td>65,536 (aka 64K)</td>
</tr>
<tr>
<td>20 binary digits</td>
<td>$2^{20}$</td>
<td>1,048,576 (aka 1M)</td>
</tr>
<tr>
<td>24 binary digits</td>
<td>$2^{24}$</td>
<td>16,777,216 (aka 16M)</td>
</tr>
<tr>
<td>30 binary digits</td>
<td>$2^{30}$</td>
<td>1,073,741,824 (aka 1G)</td>
</tr>
<tr>
<td>1 decimal digit</td>
<td>$10^1$</td>
<td>10</td>
</tr>
<tr>
<td>4 decimal digits</td>
<td>$10^4$</td>
<td>10,000</td>
</tr>
</tbody>
</table>

Notice that with four binary digits, you can represent 16 different combinations. With one hexadecimal digit, you can also represent 16 different combinations. Because of this, we say that one hexadecimal digit equals four binary digits. This is why converting between binary and hexadecimal is relatively easy. It is also why hexadecimal representation is used so often in computing. Rather than writing a 24-digit binary number, you can write a 6-digit hexadecimal number (since 6 hexadecimal digits equals 24 binary digits).

Complete the following table to show how many combinations you can represent with each of the listed numeric values.

<table>
<thead>
<tr>
<th>Numeric value</th>
<th>Formula</th>
<th>Number of combinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>32 bits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 octal digits (base 8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48 bits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 hexadecimal digits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 upper-case alphabetic characters</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Range of Possible Values

Similar to the number of possible combinations that you can represent with a numeric value, you can determine the range of possible values.

<table>
<thead>
<tr>
<th>Numeric value</th>
<th>Combinations</th>
<th>Combinations</th>
<th>Range</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 binary digits</td>
<td>$2^4$</td>
<td>16</td>
<td>0 - $2^4$-1</td>
<td>0 - 15</td>
</tr>
<tr>
<td>8 binary digits</td>
<td>$2^8$</td>
<td>256</td>
<td>0 - $2^8$-1</td>
<td>0 - 255</td>
</tr>
<tr>
<td>10 binary digits</td>
<td>$2^{10}$</td>
<td>1,024 (aka 1K)</td>
<td>0 - $2^{10}$-1</td>
<td>0 - 1023</td>
</tr>
<tr>
<td>4 decimal digits</td>
<td>$10^4$</td>
<td>10,000</td>
<td>0 - $10^4$-1</td>
<td>0 - 9,999</td>
</tr>
</tbody>
</table>

The range of possible values that can be represented with a numeric value is:

$$0 - b^n$$

Complete the following table to show the range of values you can represent with each of the listed numeric values.

<table>
<thead>
<tr>
<th>Numeric value</th>
<th>Combinations</th>
<th>Range of values</th>
</tr>
</thead>
<tbody>
<tr>
<td>32 bits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 hexadecimal digits</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Unluckily, the terms K, M, G, and T are used loosely and, even worse, inconsistently in computing. In some cases, these units are used to express a power of 10. In other cases, they are used to express a power of 2. It makes a big difference.

When we talk about any type of storage capacity, such as an amount of RAM or of disk, these units are supposed to express a power of 2, as shown in the following table.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Power of 2</th>
<th>Actual value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1K</td>
<td>$2^{10}$</td>
<td>1,024</td>
</tr>
<tr>
<td>1M</td>
<td>$2^{20}$</td>
<td>1,048,576</td>
</tr>
<tr>
<td>1G</td>
<td>$2^{30}$</td>
<td>1,073,741,824</td>
</tr>
<tr>
<td>1T</td>
<td>$2^{40}$</td>
<td>1,099,511,627,776</td>
</tr>
</tbody>
</table>

If you buy 1G of RAM, you will get 1,073,741,824 bytes of RAM. No doubt about it.

When we talk about speed or throughput, such as the speed of a 1GHz CPU or the throughput of a 1Mbps DSL connection, these units are used to express a power of 10, as shown in the following table.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Power of 10</th>
<th>Actual value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1K</td>
<td>$10^3$</td>
<td>1,000</td>
</tr>
<tr>
<td>1M</td>
<td>$10^6$</td>
<td>1,000,000</td>
</tr>
<tr>
<td>1G</td>
<td>$10^9$</td>
<td>1,000,000,000</td>
</tr>
<tr>
<td>1T</td>
<td>$10^{12}$</td>
<td>1,000,000,000,000</td>
</tr>
</tbody>
</table>

A 1GHz CPU really does run at an "even" 1,000,000,000 cycles per second. A 1Mbps DSL internet connection really does have an "even" 1,000,000 bits per second throughput.

You need to be very careful, and pay attention to the context in which the units K, M, G, and T are used. When they are used to measure storage capacity, they are supposed to express a power of 2. When they are used to measure speed or throughput, they express a power of 10.
To really mess things up, disk manufacturers frequently do not abide by this convention. If you buy a 1GB hard disk, you would expect to get 1,073,741,824 bytes of disk capacity. Unfortunately, you will probably get 1,000,000,000 bytes of disk capacity. This really confuses users.

<table>
<thead>
<tr>
<th>Advertised Capacity</th>
<th>What you expect (power of 2)</th>
<th>What you get (power of 10)</th>
<th>&quot;Real&quot; size of the disk</th>
</tr>
</thead>
<tbody>
<tr>
<td>500MB</td>
<td>524,288,000</td>
<td>500,000,000</td>
<td>500,000,000/1,048,576</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>476.8MB</td>
</tr>
<tr>
<td>1GB</td>
<td>1,073,741,824</td>
<td>1,000,000,000</td>
<td>1,000,000,000/1,073,741,824</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.93GB</td>
</tr>
<tr>
<td>100GB</td>
<td>107,374,182,400</td>
<td>100,000,000,000</td>
<td>100,000,000,000/1,073,741,824</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>93.1GB</td>
</tr>
</tbody>
</table>

Complete the following table to show how much RAM or Disk you would expect for each of the following:

<table>
<thead>
<tr>
<th>Actual Bytes of RAM or Disk</th>
</tr>
</thead>
<tbody>
<tr>
<td>64K</td>
</tr>
<tr>
<td>512M</td>
</tr>
<tr>
<td>10G</td>
</tr>
<tr>
<td>4T</td>
</tr>
</tbody>
</table>

Complete the following table to show how many cycles per second a CPU would execute if it ran at the listed speed.

<table>
<thead>
<tr>
<th>Cycles per Second</th>
</tr>
</thead>
<tbody>
<tr>
<td>64KHz</td>
</tr>
<tr>
<td>512MHz</td>
</tr>
<tr>
<td>10GHz</td>
</tr>
<tr>
<td>4THz</td>
</tr>
</tbody>
</table>

Be sure to submit your online Homework Review form. The form is actually graded for a grade. (For most assignments, the online form is not graded per se, but is more of a checklist. Your actual answers on the form do not matter; but you must submit your form.)
1. Download a copy of SiSoft Sandra, which is a great (and free!) set of programs that you can use on your computer to get all sorts of hardware information. A link to SiSoft Sandra's web site is provided in your Private Course Web Site.

When you get to the SiSoft Sandra web site, follow the link "Download SiSoft Sandra Standard" and then the ensuing downloading instructions. You will need an unzipping program to decompress the downloaded file, which is approximately 2.2MB in size.

2. After you download and install your software, you will run it to get specific hardware information about your computer. But while the program is downloading, fill in the following table based on what you expect the answers to be for the computer on which you will run the benchmark program. If you don't have any idea about the answer to a question, just leave that cell blank.

<table>
<thead>
<tr>
<th>CPU model</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU speed</td>
<td></td>
</tr>
<tr>
<td>amount of RAM</td>
<td></td>
</tr>
<tr>
<td>size of L1 cache</td>
<td></td>
</tr>
<tr>
<td>size of L2 cache</td>
<td></td>
</tr>
<tr>
<td>Hard disk make/model</td>
<td></td>
</tr>
<tr>
<td>Hard disk controller make/model</td>
<td></td>
</tr>
<tr>
<td>Maximum monitor resolution</td>
<td></td>
</tr>
</tbody>
</table>
3. When you finish downloading, unzip the file, then install your software. You should end up with a folder full of various programs that you can run to get information about your computer. Spend some time looking at the mounds of information available, then fill in the cells in the table below as best as possible.

SiSoft Sandra may, or may not, give you all of the information that you need for this table. If you can’t find the information, just leave the corresponding cell blank.

<table>
<thead>
<tr>
<th>CPU model</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU speed</td>
<td></td>
</tr>
<tr>
<td>amount of RAM</td>
<td></td>
</tr>
<tr>
<td>size of L1 cache</td>
<td></td>
</tr>
<tr>
<td>size of L2 cache</td>
<td></td>
</tr>
<tr>
<td>Hard disk make/model</td>
<td></td>
</tr>
<tr>
<td>Hard disk controller make/model</td>
<td></td>
</tr>
<tr>
<td>Maximum monitor resolution</td>
<td></td>
</tr>
</tbody>
</table>

Be sure to submit your Online Homework form. This form is not graded per se, but is more of a checklist. Your actual answers on the form do not matter; but you must submit your form.
Assignment #4

System Info, part 2

If you have any concerns about removing the cover from your computer, remember that this assignment can be done in groups. Find a group. Do not risk destroying your computer if you do not feel comfortable removing the cover.

1. Complete the following table as well as possible. You may be able to answer some questions without removing the cover from your computer. For others, you will almost certainly need to remove the cover.

<table>
<thead>
<tr>
<th>Description</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>motherboard form factor (ATX, non-ATX)</td>
<td></td>
</tr>
<tr>
<td>type of motherboard power supply connector (single- or double-keyed)</td>
<td></td>
</tr>
<tr>
<td>CPU connector (socket or slot)</td>
<td></td>
</tr>
<tr>
<td>RAM modules (how many, what type)</td>
<td></td>
</tr>
<tr>
<td>expansion slots (how many, what type)</td>
<td></td>
</tr>
<tr>
<td>motherboard manufacturer</td>
<td></td>
</tr>
<tr>
<td>motherboard model number</td>
<td></td>
</tr>
<tr>
<td>BIOS manufacturer</td>
<td></td>
</tr>
<tr>
<td>BIOS version</td>
<td></td>
</tr>
</tbody>
</table>
2. Remove the cover from the case of your computer. Oh, wait, turn your computer off first. Why is it important to turn the computer off before you remove the cover?

3. For what devices does your motherboard provide onboard support? Indicate for each one whether you are actually using the onboard support or not.

4. Replace the cover. Boot your computer. How do you run your CMOS program?

5. If you can find any identification of the manufacturer or model number of your CPU, go to the manufacturer's web site and see if there is any good information available for your motherboard. For instance,

   Is your BIOS the current version?

   Is there a schematic provided for your motherboard?

   Describe at least one hardware, motherboard-based configuration option for your computer.

6. Does your BIOS chip appear to be flash upgradeable?
7. The speed of a RAM module is typically stated in seconds per cycle, not in the cycles per second (Hertz) that we use in other areas of computing. Seconds per cycle is the inverse of cycles per second.

$1 \text{ns} = .000000001 \text{ seconds}$ (9 decimal places)

$10 \text{MHz} = 10,000,000 \text{ cycles per second}$
   $= 1 \text{ second}/10,000,000 \text{ cycles}$
   $= .000000010 \text{ seconds per cycle}$
   $= 100 \text{ns}$

$100 \text{MHz} = 100,000,000 \text{ cycles per second}$
   $= 1 \text{ second}/100,000,000 \text{ cycles}$
   $= .0000000010 \text{ seconds per cycle}$
   $= 100 \text{ns}$

$800 \text{MHz} = 800,000,000 \text{ cycles per second}$
   $= 1 \text{ second}/800,000,000 \text{ cycles}$
   $= .0000000125 \text{ seconds per cycle}$
   $= 1.25 \text{ns}$

$1 \text{GHz} = 1,000,000,000 \text{ cycles per second}$
   $= 1 \text{ second}/1,000,000,000 \text{ cycles}$
   $= .000000001 \text{ seconds per cycle}$
   $= 1 \text{ns}$

$2 \text{GHz} = 2,000,000,000 \text{ cycles per second}$
   $= 1 \text{ second}/2,000,000,000 \text{ cycles}$
   $= .0000000005 \text{ seconds per cycle}$
   $= .5 \text{ns}$

Thus, 1.25ns RAM runs at the same speed as an 800MHz CPU.

Complete the following table to express each cycle rate in ns (nanoseconds):

<table>
<thead>
<tr>
<th>Cycle Rate</th>
<th>ns</th>
</tr>
</thead>
<tbody>
<tr>
<td>1MHz</td>
<td></td>
</tr>
<tr>
<td>50MHz</td>
<td></td>
</tr>
<tr>
<td>500MHz</td>
<td></td>
</tr>
<tr>
<td>4GHz</td>
<td></td>
</tr>
</tbody>
</table>
8. If you had a 100MHz frontside bus, what RAM speed would you want?

9. Complete the following table to show the throughput of each of the following types of DIMM modules:

<table>
<thead>
<tr>
<th>RAM speed</th>
<th>Cycle Rate</th>
<th>RAM width (in Bytes)</th>
<th>Throughput (in MBps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10ns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5ns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2ns</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10. Complete the following table to show the parity bit that would be set for each of the listed 8-bit bytes under odd parity:

<table>
<thead>
<tr>
<th>8-bit byte</th>
<th>Parity bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>10100101</td>
<td></td>
</tr>
<tr>
<td>11001101</td>
<td></td>
</tr>
<tr>
<td>10110010</td>
<td></td>
</tr>
<tr>
<td>00110101</td>
<td></td>
</tr>
<tr>
<td>00000000</td>
<td></td>
</tr>
<tr>
<td>11111111</td>
<td></td>
</tr>
</tbody>
</table>
Assignment #5

Video

If you have any concerns about removing the cover from your computer, remember that this assignment can be done in groups. Find a group. Do not risk destroying your computer if you do not feel comfortable removing the cover.

1. Turn off your computer and remove the cover. Unplug the monitor cable from the back of your computer (from the back of the graphics card). What type of plug is on the end of the monitor cable?

What type of port is on the graphics card?

2. Remove the graphics card. Into what type of slot does your graphics card plug?

3. Examine your graphics card. Write down any information that might help you identify the type of card so you can get information about the card (manufacturer, model number, etc.). There will be one main chip on the graphics card; be sure to write down information from that chip. If your graphics card is a 3D card, you might want to check Table 8.10 in our book for more information.
4. Write down any information that is visible on your monitor that might help you find information about the monitor (manufacturer, model number, etc.). There is probably a label on the back of the monitor that has information.

5. Plug the graphics card back in, replace the computer's cover, and plug your monitor back into the computer. Reboot the computer.

6. During the rebooting sequence, get into your CMOS setup program. If your motherboard provides onboard support for COM and LPT ports, there will be information available in CMOS. For instance, if you wanted to add an internal modem as COM2, you would configure the modem for COM2 (via jumpers, dip switches, or software, depending on your modem), plug the modem into an available expansion slot, and then get into CMOS and disable the motherboard's onboard COM2 so the onboard COM2 would not conflict with the modem.

Find the information that your CMOS provides for your ports.

<table>
<thead>
<tr>
<th></th>
<th>COM1</th>
<th>COM2</th>
<th>LPT1</th>
</tr>
</thead>
<tbody>
<tr>
<td>enabled/disabled</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRQ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/O port</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. Exit CMOS and reboot your computer. Use the world wide web to find information about your monitor (go to the manufacturer's web site, search for model number, do whatever you can think of to find information).

Based on the information you find about your monitor, fill out the following table as completely as possible.

<table>
<thead>
<tr>
<th></th>
<th>COM1</th>
<th>COM2</th>
<th>LPT1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagonal screen measure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viewing area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dot pitch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal scan frequency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical scan frequency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum resolution</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
8. Our book goes through some VRAM calculations. The diagram below demonstrates how VRAM is used to store data used to refresh the monitor. Each pixel on the monitor (abbreviated p in the diagram) has a corresponding 3 bytes of VRAM allocated to support that pixel (abbreviated 3B in VRAM diagram). To display output, the RGB values for an individual pixel are stored in the corresponding VRAM location. Each VRAM location is 3 bytes, or 24 bits (hence the name 24-bit color), with 1 byte used for the intensity of the Red phosphor, 1 byte for the intensity of the Green phosphor, and 1 byte for the intensity of the Blue phosphor. 1 byte (8 bits) for each color provides $2^8$, or 256, intensity levels for each color. Combining all 3 bytes (24 bits), this system supports $2^{24}$, or 16,777,216 different colors (intensity level combinations of Red, Green, and Blue).
With 24-bit color (also called RGB color, or perhaps True Color), you need 3 bytes of VRAM for each pixel on the screen. At a resolution of 640x480 (640 pixels horizontally across the screen, 480 pixels vertically down the screen), you need 640*480*3 = 921,600 bytes of VRAM.

There are numerous possible color systems that do not store an RGB value in VRAM for each pixel on the screen. 4-bit color, 8-bit color, and 16-bit color all use a palette of colors selected from the 16,777,216 colors provided by RGB. In the diagram below, 4-bit color is shown.

In 4-bit color, 4 bits of VRAM are used for each pixel on the screen. In each VRAM location, we no longer store 3 bytes of RGB intensity data. Instead, we store a 4-bit palette index (values range 0-15).

4-bit color uses a palette of $2^4$, or 16, different colors. Each entry in the palette requires 3 bytes of VRAM; one of those bytes represents an intensity of Red, one byte Green, and one byte Blue. The palette can store 16 different colors selected from the possible range of the 16,777,216 colors that can be represented with 24 bits.

The palette is constructed and stores intensity data for 16 different colors. Each VRAM location requires 4 bits to store a palette index number, which can range from 0-15.
With 4-bit color, you need 4 bits of VRAM for each pixel on the screen. At a resolution of 640x480, you need 640x480x4 = 1,228,800 bits, or 153,600 bytes. You also need to store the palette itself. In this case, 16 palette entries of 3 bytes each is an additional 48 bytes of VRAM needed. The total amount of VRAM needed in this case is 153,648 bytes.

Calculate the amount of VRAM required in each of the following situations:

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Color system</th>
<th>Uses palette?</th>
<th>VRAM required</th>
</tr>
</thead>
<tbody>
<tr>
<td>800x600</td>
<td>4-bit</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>800x600</td>
<td>8-bit</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>1024x768</td>
<td>8-bit</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>1024x768</td>
<td>16-bit</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>1024x768</td>
<td>24-bit</td>
<td>no</td>
<td></td>
</tr>
</tbody>
</table>
Assignment #6

Hard Disk, part 1

1. Boot a computer and get into the CMOS setup program. Who is the maker of your CMOS program?

Examine CMOS options to determine the following settings, if they are available. Indicate the setting for each item.

Onboard support:
  primary IDE: _________________________
  secondary IDE: _________________________
  floppy disk controller (FDC): _________________________
  serial port #1: _________________________
  serial port #2: _________________________
  parallel port #1: _________________________

Examine options to see if you can find anything about LBA mode. Can you? Is it enabled?

Describe the current settings for ROM BIOS shadowing, if any information is available.

2. Supply the following values based on your CMOS settings for your primary hard drive:

Cylinders: _________________________

Heads: _________________________

Sectors/track: _________________________

Based on these values, what is the exact capacity of the drive?
3. Using SiSoft Sandra or any other means, answer the following questions.

Type of processor: ______________________________

Amount of RAM: ______________________________

Size of your hard drive: ______________________________

Type of FAT: ______________________________
1. Assume that your hard drive has 936 cylinders, 4 heads, and 9 sectors per track. How many total sectors are on the disk? If each sector stores 512 bytes, what is the exact capacity of the hard drive?

What is the capacity in kilobytes (to two decimal places)?

What is the capacity in megabytes (to two decimal places)?

2. Assume that you have a disk with the following device characteristics:

- 1024 cylinders
- 8 surfaces
- 63 sectors per track
- 12ms average seek time
- 4ms minimum seek time

Assume also that the disk spins at 5400rpm and can transfer data to the computer at a rate of 10,485,760 bytes per second.

What is the capacity of each track on the disk?

What is the capacity of each cylinder on the disk?

What is the total capacity of the disk?
Assume that you have a file with the following characteristics:

10,000 records
95 logical record length (LRL)

What blocking factor will be used to store the file? That is, how many whole records will fit into one block (into one sector)?

How many blocks will be required to store the entire file?

Storing one block per sector, how many blocks can you store in one cylinder?

How many cylinders will be required to store the file?

Reading blocks from the file will require three components of time: Seek time, Latency time, and Data Transfer time.

Calculate the total amount of Seek time that will be required to read the file. You will need to position the Read/Write mechanism to read the first block of records. This seek will require one average seek (in this case, 12ms, or .012 seconds). Because this file was stored using the **cylinder concept**, you won't need to position the R/W mechanism again until you have read an entire cylinder of blocks. And then, you will only have to move the mechanism one cylinder (next door), which requires only a minimum seek (in this case, 4ms). Given this, what is the total Seek time to read the file?

Calculate the total amount of Latency time that will be required to read the file. We assume one half rotation of the disk for each block read. Why?

Given the rotational speed of this disk, how long does each rotation of the disk take?
What is the total Latency time to read the file?

Finally, calculate total Data Transfer time, the total time required to actually read and transfer the data from the file. How many characters are in the file?

How long will it take to transfer all those characters?

What is the total amount of time that will be required to read the entire file?

3. If your file in the previous question was not stored using the cylinder concept, then we could not assume that we read a whole cylinder at a time. We would have to assume the worst, which is that we would have to move the R/W mechanism (an average seek) for each and every block read. What change would this make in your previous calculations?

When your disk is fragmented, files are not stored based on the cylinder concept. Although there are surely some blocks stored contiguously, disk performance (and, specifically, seek time) is degraded when your disk is fragmented.

On a network server hard drive, you share the disk, and the read/write mechanism, with other users. After you read a block of data, it is highly possible that some other user will read a block from somewhere else on the disk before you read your next block. What difference would this make in your calculations?
For study purposes, perform the calculations to complete the table below for two different hard drives. In each case, assume a file with 60,000 records with a LRL of 80.

<table>
<thead>
<tr>
<th></th>
<th>Disk #1</th>
<th>Disk #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>cylinders</td>
<td>2048</td>
<td>1860</td>
</tr>
<tr>
<td>heads</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>sectors/track</td>
<td>63</td>
<td>56</td>
</tr>
<tr>
<td>average seek time</td>
<td>9ms</td>
<td>12ms</td>
</tr>
<tr>
<td>minimum seek time</td>
<td>3ms</td>
<td>3ms</td>
</tr>
<tr>
<td>rotation speed</td>
<td>5400rpm</td>
<td>7200rpm</td>
</tr>
<tr>
<td>data transfer rate</td>
<td>15,728,640B/sec</td>
<td>13,631,488B/sec</td>
</tr>
</tbody>
</table>

Total disk capacity

Blocks to store

Cylinders required

Total seek time

Total latency time

Total data transfer time
Assignment #8

Hard Disk, part 3

1. What is the maximum number of entries that can be stored in a FAT 16 File Allocation Table?

What is the maximum number of entries that can be stored in a FAT 32 File Allocation Table?

Complete the following table, calculating the maximum size drive that can be supported based on FAT type and cluster size.

<table>
<thead>
<tr>
<th>FAT type</th>
<th>Cluster size (bytes)</th>
<th>Maximum size hard drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAT 16</td>
<td>4,096</td>
<td></td>
</tr>
<tr>
<td>FAT 16</td>
<td>8,192</td>
<td></td>
</tr>
<tr>
<td>FAT 16</td>
<td>32,768</td>
<td></td>
</tr>
<tr>
<td>FAT 32</td>
<td>4,096</td>
<td></td>
</tr>
<tr>
<td>FAT 32</td>
<td>32,768</td>
<td></td>
</tr>
</tbody>
</table>

2. Exit to the DOS prompt and run CHKDSK. Supply the following values based on your output.

size of each disk allocation unit: _________________________

total allocation units on the disk: _________________________

Based on these two values, what is the exact capacity of your hard drive?

What is the capacity in kilobytes (to two decimal places)?

Back to the CHKDSK output...

available allocation units: _________________________

total kilobytes disk space: _________________________

kilobytes free: _________________________
3. To test the concept of allocation unit, create a small file. Use a text editor, or use the Copy command to copy keystrokes from the keyboard into a text file:

copy con test.dat

(This command copies from the console to test.dat. To close the file, press control-Z, for end of file, then Enter).

How many characters did you type into the file (note that each time you press Enter, two characters are stored in the file: CR and LF)?

Type DIR. What does DIR list as the size of the file?

Run CHKDSK again, and supply the following values.

available allocation units: _________________________

kilobytes free: _________________________

How many allocation units were allocated to the file?

How much disk space was allocated to the file?

How much cluster waste did you just experience? That is, how much wasted disk space was allocated to the file?

4. From the root directory of your C: drive, type DIR/S to count how many files you have stored on the drive. How many files are stored on your drive?

If each file has one half cluster as cluster waste, how much total disk space are you losing here?
5. Get back in Windows. Double-click on My Computer, then right-click on your C: drive. Select Explore from the menu.

Before proceeding with this step, customize some options for your listings of files. Select View, then Folder Options. From the next screen, select View. You can now customize some properties for your file listings. Under Hidden Files, select Show All Files.

After exploring any options that interest you, close the View menus. You should see two panes of directory information. Click inside the right pane, then select (from the top menus) Edit, Select All. This should highlight all files in the right pane. Click on the Properties icon on the toolbar at the top of the screen. The screen will calculate the number and sizes of all the files you have selected.

When the calculation is complete, you will see two different figures for Size. The first is the total actual size of the files selected; the second figure is the amount of disk space allocated. Calculate how much disk space is lost to cluster waste.

Allocated disk space: ______________________________
Actual required disk space: ______________________________
Cluster waste: ______________________________

How does this figure compare with your earlier estimate of total cluster waste?

6. Get back into Windows and click on Start, Programs, Accessories, System Tools, Disk Defragmenter. Defragment your hard drive. This could take quite a while.

When you get into Disk Defragmenter, click on Settings and un-select Check the Drive for Errors (this will make the defragmenting process go much faster, but you should probably let Disk Defragmenter actually check the disk for errors in normal situations).

When you start the defragmenting process, click on Show Details to see more information. Also click on Legend to see what the tiny little indicators on the screen mean.

What does defragmenting your hard drive do?

NOTE: You can start work on questions 7 and 8 while your disk is defragmenting.

7. After running Disk Defragmenter, return to the DOS prompt and run CHKDSK. Did Disk Defragmenter free up any disk space? Why, or why not?
A sample 50-question Exam 2 is available via the Online Assignment #9 link on our Private Course Web Site. Take that exam as this homework assignment. The exam will be pre-graded (like the Online Quizzes). You may work together. You may take the exam several times. Your highest grade from that exam will be used as this homework grade.
Assignment #10

Network Fundamentals

This assignment should be completed using a computer that is attached to a network. If you have a home network, you can use one of your home computers. Otherwise, you might want to use a computer in an on-campus lab.

The 7-layer OSI model breaks the entirety of networking into seven categories. Every piece of hardware, every piece of software, every protocol (rule) relates to one (or possibly more) layer of the OSI model.

<table>
<thead>
<tr>
<th>Layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
</tr>
<tr>
<td>Presentation</td>
</tr>
<tr>
<td>Session</td>
</tr>
<tr>
<td>Transport</td>
</tr>
<tr>
<td>Network</td>
</tr>
<tr>
<td>DataLink</td>
</tr>
<tr>
<td>Physical</td>
</tr>
</tbody>
</table>

(To remember the layers, from bottom to top, use the acronym: Programmers Do Not Throw Sausage Pizza Away -- PDNTSPA.)

The Physical Layer

The Physical Layer is responsible for the physical transmission of bits from the sending node to the receiving node. Standards at the physical layer help us achieve interoperability and interconnectivity. 10Base2, for instance, uses RG58 thin coaxial cable, and BNC connectors. The various manufacturers of these components must adhere to the standard specifications for the physical characteristics of the components if they want their parts to fit parts manufactured by other companies. Other physical characteristics, such as the speed and voltage of an electrical signal, also relate to this layer of the OSI model.

Is your network transmission wired (also called conducted) or wireless (also called radiated)?

If your network transmission is conducted, what type of network cable are you using?

What type of connector is used to plug the network cable into your network interface card?

What is the protocol data unit (PDU) at the physical layer?
The DataLink Layer

The DataLink layer is responsible for *physical addressing*. It is also responsible for *controlling access to the medium* (the network medium). To accomplish these tasks, each network interface card has a *physical address*. In most cases today, the physical address is burned into a ROM chip on the card. On some older NICs, the physical address is set with DIP switches, jumpers, software, or some other configuration device.

Go to the DOS prompt (in Windows NT, Windows 2000, or Windows XP, click on Start, Run, then type cmd.exe; better yet, create a shortcut icon to cmd.exe so you can easily get to the DOS prompt in the future).

Type the following command at the DOS prompt:

```
    ipconfig /all | more
```

This runs the program ipconfig.exe, specifying the /all switch (which will cause the generation of more information than the standard ipconfig). The | character “pipes” the output of ipconfig to the more command, which will pause your output screen by screen.

(In older versions of Windows, you would run winipcfg. In Linus, run ifconfig.)

ipconfig will display your NIC’s physical address, as a 12-digit hexadecimal number.

What is your NIC’s physical address?

How many bits are in your physical address?

What is your NIC’s physical address, in binary?

What is the protocol data unit (PDU) at the datalink layer?

(A physical address is also called a MAC address, since it is used to control access to the medium. It is also sometimes called an ethernet address.)
The Network Layer

The Network Layer is responsible for *logical addressing*. A logical address is simply assigned to a node on a network. It is assigned via software. The logical address can be changed very easily.

Use the output from the ipconfig command to complete the following table.

<table>
<thead>
<tr>
<th>Your value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP address</td>
</tr>
<tr>
<td>Default gateway</td>
</tr>
<tr>
<td>DHCP server</td>
</tr>
<tr>
<td>Primary DNS server</td>
</tr>
</tbody>
</table>

What is the protocol data unit (PDU) at the network layer?

Page 48 shows an IP packet. One of the field’s in the IP packet is *recipient’s address*. Is that address a physical address, or a logical address?

**Review**

What is the difference between a physical address and a logical address?

Is an IP address a physical address, or a logical address?

Does a Network Layer protocol, such as IP, need to know whether it is communicating with the network via a conducted or radiated transmission? That is, does the Network Layer protocol need to know what type of transmission it is using, or not?
Assignment #11

Ethernet

The *physical topology* of a network is defined by the actual layout of the nodes and the medium connecting the nodes. The *logical topology* is defined by the way the data flows through the network.

Page 99 shows a diagram that could be either a 10Base2 or a 10Base5 network. What is the topology of this network?

The arrow in the diagram shows that data travels along the trunk cable, and is received by each node on the network. What logical topology does this define?

What MAC technique does this network use?

If this is a 10Base2 network, what is the maximum length of the trunk segment on the network?

Page 112 shows two 10Base2 segments connected by a repeater. At what OSI layer does a repeater operate?

Page 114 shows two 10Base2 segments connected by a bridge. At what OSI layer does a bridge operate?

What is the difference between a repeater and a bridge? Let me start your answer for you:

Since a repeater operates at the OSI _________ layer, and a bridge operates at the _________ layer,
In 10Base2, how many 185 meter segments may be connected together into a single collision domain?

Page 75 shows a diagram of a 10BaseT network. What is the physical topology of this network?

Assume that the hub device is a multi-port repeater. At what OSI layer does a repeater operate?

Assume that the hub device is a switch. At what OSI layer does a switch operate?

What is the difference between a multi-port repeater and a switch?

What is the logical topology of a 10BaseT network if a multi-port repeater is used as the hub device?

What is the logical topology of a 10BaseT network if a switch is used as the hub device?
Assignment #12

Ethernet and Non-Ethernet Networks

One of the major responsibilities of the DataLink Layer is Medium Access Control (MAC) -- controlling access to the network medium. The MAC technique used by a network is an important characteristic of the network.

Ethernet networks use CSMA/CD as their MAC technique. The other major MAC technique is token-passing.

What is the disadvantage of CSMA/CD?

Page 156 shows a diagram of a Token Ring network. What is the physical topology of this network?

What is the logical topology of this network?

What MAC technique does this network use?

IEEE 802.11b describes the specifications for 11Mbps wireless networking. This network uses an access point (shown on page 227) as the hub of the network. 802.11b describes two different types of networking: infrastructure mode and ad hoc mode.

In infrastructure mode, each computer in the network communicates with the access point (AP). What is the logical topology of this network?

In ad hoc mode, each computer communicates directly with every other computer on the network. What is the logical topology of this network?
Assignment #13

Netware Installation

In this assignment, your group of three students will install Novell Netware 3.11 on a file server. Your group will also install Windows 98 on a client computer. You will use a third computer as a second client computer in your network; all software is already installed on that computer. For the remainder of this assignment, the three computers will be referred to as "Netware server", "Windows client", and "DOS client".

Your instructor will supply a Windows 98 Setup Boot Disk (floppy disk) and a Windows 98 CD for your Windows client installation. Your instructor will also supply a Netware Server Boot Disk and seven Netware diskettes for your Netware server installation. Finally, your instructor will supply a DOS 6.22 Boot Disk for your DOS-based client computer. All of these diskettes should be available in McCool 371 at the time of your installation appointment, along with the three computers. The seven Netware diskettes are labelled as follows:

- SYSTEM-1
- SYSTEM-2
- SYSTEM-3
- DOSUTIL-1
- DOSUTIL-2
- DOSUTIL-3
- DOSUTIL-4

At your appointment time, go to McCool 371 to perform your Netware installation. Three computers are available on the table underneath the Boston Marathon picture.

The three computers are labeled as to their purpose: Netware server, DOS client, Windows 98.

The remainder of this assignment gives detailed instructions for the installation of networking software on each of your three computers. When you get to a step that requires a long wait on one computer, you might want to go ahead and begin installation on one of your other computers.

Overview:

1. You will be installing a 10BaseT network. An 8-port Ethernet hub will be available. This hub has eight RJ-45 ports. It also has a BNC connector on the back of the hub (you won't be using the BNC connector). Your Netware server, your Windows client, and your DOS client will each plug into one of the RJ-45 ports, using unshielded twisted pair (UTP) wire for the network medium.

2. Examine all of the hardware in your network to familiarize yourself with all of the components.
Windows 98 Client computer:

1. Boot the Windows 98 client computer with your "Windows client" boot diskette, and run FDISK.

   \texttt{fdisk}

   You will be asked if you want to enable “Large Disk Support.” You do.

   FDISK has four main menu options. Select option 4 to view any existing disk partitions. If there are any partitions, use option 3 to delete them. You must delete partitions in LIFO (Last In, First Out) order. If you have more than one partition, you will have to delete the last one first. Use option 4 again to be sure that there are "no partitions defined".

   When you have "no partitions defined", use option 1 to create a primary DOS partition.

   When you select option 1 to create a Primary DOS Partition, you will be asked “Do you wish to use the maximum available size for a Primary DOS Partition and make the partition active?”

   This is where you decide whether you want to partition your physical drive or not (probably to reduce cluster waste, if possible).

   Formatting a large drive takes MUCH LONGER than formatting a small drive. It is highly recommended that for this assignment, you answer N to this question. Create a small Primary DOS Partition, not a large one.

   Answer N. After the drive integrity has been checked, specify a size of 1024 for your partition.

   Although you could create several smaller partitions, in this case it makes sense to create one single partition. Use the "maximum available size for a Primary DOS partition" and "make the partition active" (a partition must be active for it to be bootable).

   You will need to reboot your computer for the changes to the partition table to take effect.

2. Reboot your computer to the floppy disk, and format your C: drive as a system disk.

   \texttt{format c: /s}

   \textbf{Do not specify a Volume Label when you format the C: drive.}
Formatting the disk is going to take several minutes. You should now start the installation of your Netware server software.

Always make sure that each member of your group is watching what the other group members are doing. Don’t work separately, work together.

3. Now it's time to start installing Windows 98. Run SETUP.EXE from the CD (the Windows 98 Installation CD should already be in the CD-ROM drive).

```
d: setup
```

4. Follow the Windows 98 installation instructions. You may use a "Typical" installation. You will not need a "Startup Disk".

---

**Do not mess up the Windows 98 installation boot disk. Do not use this disk to create a Startup Disk. You do not need a Startup Disk.**

---

5. It will take quite some time for the Windows 98 installation program to run. During the meantime, you should begin (or continue) the installation of your Netware server software.

6. At some point, you will be asked for a Windows 98 "Product Key". The correct value is:

```
QYVT7-M36W9-3XVB8-344PX-3R6PQ
```

7. When the installation finally finishes and you actually boot into Windows 98, you will see a login screen for Microsoft Networking. Wait at that prompt until you finish your Netware server installation.

8. When your server is up and running, click on "Cancel" to bypass Microsoft Networking.

9. Once you have gone through all the annoying Windows 98 start-up junk, like turning off all the automatic cutesy stuff and bypassing registration, double-click on "My Computer", "Control Panel", and "Network".

You will see a list labeled "The following network components are installed". By default, "Client for Microsoft Networks" will have been installed. Click on the "Add" button (underneath the list) to also install "Client for Netware Networks).

You will be asked to "Click the type of network component you want to install". Double-click on "Client". Click on the well-known manufacturer "Microsoft", then double-click on "Client for Netware Networks". Wait.
When you return to the list of installed network components, change the "Primary Network Logon" to "Client for Netware Networks".

Click on the "OK" button.

At points, it will seem like nothing is happening. Eventually, however, you will be told that you must restart your computer before these changes will take effect. Restart your computer.

10. When you reboot, specify Guest as the login id. Specify your server name. If you have MONITOR.NLM loaded on your server, you should see the connection information immediately.

Double-click on "Network Neighborhood". You should be able to access your server.

If this all works, you're doing great!
Netware Server computer:

1. Boot your Netware server with the diskette labelled "Netware Server Boot Disk" (this diskette boots into MSDOS 6.22). As before, run FDISK. Remove any existing partitions.

   You will need to remove partitions on a LIFO basis. Remove partition number 2 (the non-DOS partition) first, then remove partition number 1, the Primary DOS partition.

   Once you have "no partitions defined", create a primary DOS partition of only 10MB.

   You do not want to use all available space for your DOS partition on your Netware server; you want only enough disk space to boot the server and run the Netware Operating System. Be sure that you create only a minimal primary DOS partition.

   Be sure to make your primary DOS partition active (menu option 2).

   Exit FDISK.

2. Reboot your server to your floppy disk. Format the C: drive as a system disk.

   \format c: /s

3. Remove the floppy diskette from the A: drive and reboot your server computer, this time booting to the C: drive.

4. Make a directory named NWSERVER; move to that directory.

   cd \
   md nwserver
   cd nwserver

5. Copy the following files from the server diskettes to the NWSERVER directory.

   from SYSTEM-1: SERVER.EXE
   from SYSTEM-2: INSTALL.NLM, NE2000.LAN, IDE.DSK

   copy a:\server.exe  
copy a:\install.nlm
   copy a:\ne2000.lan  
copy a:\ide.dsk

   .NLM files are Netware Loadable Modules. These are programs that you run on the file server itself (run an .NLM with the Load command at the file server prompt).
   .LAN files are LAN drivers -- a NIC-specific driver for the file server's NIC.
   .DSK files are Disk drivers -- a table of disk characteristics that the file server uses to manage your file server disk device.
6. Run SERVER.EXE.

server

7. Assign your server a name. Your server name must be unique on your network. You can pick any server name that you want (COBILAN, MIS, and MISLAB are existing server names in McCool Hall)

8. Assign your server an IPX Internal Network Number (server number). The server number must be unique on your network. You can pick any number that you want.

9. You will land at the console prompt, which is a simple colon (:) prompt. This is not a DOS prompt, and DOS commands, such as dir and copy, will not work here. This is definitely not a GUI interface! The console prompt is probably not for the weak-hearted! The only things that make sense at the console prompt are console commands, such as Load, Unload, Down, and Exit.

10. Load your Netware disk driver.

load ide

Your disk and controller card are set at their default settings. Accept defaults for I/O port and Interrupt number by simply pressing <Enter> when asked for those settings.

11. Load your NIC driver.

load ne2000

Your network card is set to use I/O port 300 and Interrupt number 3. Specify these settings when you load your LAN driver.

If you mess up and load a module incorrectly, you can unload the module with the Unload command, such as:

unload ne2000

12. Bind the IPX protocol to your NIC driver.

bind ipx to ne2000

You will be asked for a Network Number. All servers on your network must use the same Network Number. Since you have only one server, you can choose any Network Number (note: it may not be the same as your IPX Internal Network Number from step 8).
Note: Once you have bound a network protocol to your LAN driver, you would have to unbind the protocol from the LAN driver if you needed to unload the driver. Thus, if you needed to do this, you would type:

unbind ipx from ne2000
unload ne2000

13. Load the INSTALL program.

**load install**

a) Using "Disk Options", create a new Netware partition.

Select "Disk Options", then "Partition Tables". You will see a list of all existing partitions (your small Primary DOS partition) and Free Space.

Select the option to "Create Netware Partition". The default partition size will be all remaining cylinders on the disk. The display will indicate the size of the partition (in MB). It will also show how many of the blocks (disk allocation units) of the partition will be used for actual data, and how many will be used for hot fix redirection.

Press <Esc> to create the partition. Wait just a moment.

b) Using the "Volume Options" main menu option, create a new volume. You will be shown a list of all existing volumes; there are none. Press <Ins> to insert (create) a new volume. It will automatically be named your SYS: volume. Press <Esc> to create the volume.

c) Once the volume has been created, select it and mount it.

---

**Be sure to mount your SYS: volume after you create it.**

---

d) Using "System Options" from the main menu, follow the on-screen directions to "Copy System and Public Files" to your Netware partition. Skip any requested disks which you don't have.

e) After copying all files to the Netware partition, use the menu options to create a STARTUP.NCF file. This file will be created based on the server commands that you have already typed. STARTUP.NCF will be stored in C:\NWSERVER (on the DOS partition) and will contain only one command: load ide.dsk

In the future, when you run SERVER.EXE, the first thing it will do is read STARTUP.NCF, which will load the disk driver. That will make the Netware partition available. When the Netware partition is available, the server boot process can continue.
f) Now use the menu options to create an AUTOEXEC.NCF file. This file will also be created based on the server commands that you have already typed. AUTOEXEC.NCF will be stored in SYS:SYSTEM (on the Netware partition). AUTOEXEC.NCF will be available for processing only after the Netware partition has been made available by STARTUP.NCF.

14. Exit to the console prompt and load MONITOR.NLM.

```
load monitor
```

MONITOR.NLM (and all other NLMs) is stored in SYS:SYSTEM.

At the server console, you can have many tasks running simultaneously. You can press <alt><Exc> to rotate through your running processes. If you hold down the <alt> key, the top line of the display will indicate the current display (such as Monitor Screen or System Console).

MONITOR.NLM is used to monitor the status of the network, including resource utilization, connection information, and much, much more.

MONITOR.NLM has an automatic screen saver called the "Netware worm". After some period of inactivity, you may see a red square moving around the screen -- this is the worm. The speed at which the worm moves, and the length of its tail, indicate the current utilization load on the server.

---

You are ready to wait for client logins!
DOS Client computer:

1. Believe it or not, your DOS client computer doesn't even have a hard drive installed. Use the DOS 6.22 Boot Disk (floppy disk), which has all required software, to boot your DOS client computer.

2. Move to the \NIC directory, then run four programs which should connect you to your server.

   cd \nic
   lsl (Link Support Layer; reads NET.CFG)
   dlrts (NIC-specific packet driver)
   ipxodi (protocol stack)
   vlm (DOS Requester)

   Attaching to your server should be relatively quick (after running VLM). You should get a message telling you that you are attached. If you don't get such a message, something is wrong.

3. When you successfully attach to your server, move to the F: drive and get a directory listing. You are actually in the \LOGIN directory of the SYS: volume at this time, and two important programs should be available.

   SLIST.COM (Server List) can be used to display a list of all available servers.

   LOGIN.EXE can be used to login to your network.

4. Login as supervisor.

   login supervisor

   By default, the supervisor account is created with no password.

5. On your server, at the MONITOR.NLM screen, check the Connection Information to see if it recognizes your connection (it will display a count of "Connections in Use". You can select the menu item "Connection Information" for more information about a particular connection.).

6. When you login as supervisor, you will automatically be placed in the SYS:SYSTEM directory. As a short exercise, move to the SYS:PUBLIC directory and run SYSCON.EXE to set a password for the Supervisor.

   cd \public
   syscon
7. SYSCON is a menu-driven program that will demonstrate the look and feel of most Netware programs.

(Because you did only a partial Netware installation, you may get some error-looking messages when you first run SYSCON. Just press a key to continue; the messages won't matter.)

From the main menu, select "User Information". You will see a list of existing user accounts. The two default accounts that are created during Netware installation are Supervisor and Guest. Highlight "Supervisor" and press <Enter> to select that item from the list (to add an item to a list, you press <Ins>; to delete an item from a list, you press <Del>). To create a new user account, press <Ins> to insert a new user onto this list; to delete an account, highlight the account and press <Del>.

8. When you select the desired user account (Supervisor), you will have a list of menu options for managing that account. Select "Change Password" and type a new password for the Supervisor account.


10. Login in to Supervisor again. You should be asked for a password.
Final steps:

1. Experiment as you want, within reason!

2. At the server, load two .NLMs which will enable the Remote Management Facility (RMF).

```
load remote         (loads REMOTE.NLM from SYS:SYSTEM)
load rspx           (loads RSPX.NLM from SYS:SYSTEM)
```

When you load REMOTE.NLM, you will be asked for a password. You will use this password from your client computer when you access the server remotely.

3. From your DOS client computer, move to the SYS:SYSTEM directory and run RCONSOLE.EXE.

```
cd \system
rconsole
```

You will see a list of all available servers that are currently running the Remote Management Facility. Select your server from the (short) list.

4. Enter the password that you specified at the server when you loaded REMOTE.NLM.

5. You will see your Netware server console screen on your DOS client computer! This is amazing! You can actually operate your server from a remote computer.

Try to load MONITOR.NLM from your client computer.

```
load monitor
```

If the NLM is already loaded, you will get an error message. Unload it!

```
unload monitor
```

Now load it again.

```
load monitor
```

There are a few slight differences between operating the file server from its own console and operating it via RCONSOLE. At the server, you can toggle between tasks by pressing <alt><Esc>. Through RCONSOLE, you toggle between server screens by pressing the numeric + key. Experiment with RCONSOLE.
6. When you finish running RCONSOLE, press <shift><Esc> on the client computer to "Quit Remote Console Session".

7. When you have finished all of your experimenting, down the server and exit to the DOS prompt.

   DOWN
   EXIT

---

**Turn all computers and monitors off.**

**Go home.**
**Reward yourself, you did a great job!**
Assignment #14

Linux Installation

In this assignment, your group of three students will install Red Hat Linux 8.0 to create a web server (and an ftp server, a telnet server, and more). Your instructor will supply two Red Hat Linux v8.0 installation CDs for your server installation. In these instructions, this computer will be referred to as your "server".

Your group will also use a Windows 98 client computer -- Windows 98 will already be installed on that computer (you installed it in assignment #5). In these instructions, this computer will be referred to as your "client". You will not need to install any software on the client computer.

At your appointment time, go to McCool 371 to perform your Linux installation. The computers are available on the table underneath the Boston Marathon picture.

The remainder of this assignment gives detailed instructions for the installation of networking software on your computers.

Overview:
Your server will be connected to an 8-port 10BaseT repeater (the repeater also has a BNC connector on the back, so you could attach a 10Base2 trunk segment to the repeater if you wanted to).

One cable from the repeater links to your Linux server; one connects to your Windows client; one cable connects to COBILAN, and from there to the campus backbone network, and from there to the rest of the internet! Your server that you install in this assignment will actually be available not only to your client computer. It will be available, via the MSU campus backbone network, to the entire internet. If you have a phone handy, you might want to call a friend towards the end of this assignment and have him or her access your web server!
**Linux Server computer:** (use the computer labeled Netware Server)

1. Insert Red Hat Linux installation CD #1 into the CD-ROM drive of your server computer. If the computer is powered off, turn it on, let it start whatever boot process it wants to start, open the CD drive, insert the CD, close the drive, and turn the computer off. Then turn it back on to boot to the CD. (Note: the Power button is labeled, on the front of the computer.)

2. The Linux installation CD will start with a text-based screen which gives you three options. You want to perform your installation in graphical mode. Press <Enter>.

3. You will see some text-based output as Linux “probes” your hardware. Linux is very good at identifying and supporting a wide range of hardware.

4. The installation program will switch to a graphical interface. For most questions, you can click on the Next button in the lower right corner.

5. When you get to the “Installation Type” question, select:

   **Server**

6. Select the option to **Automatically partition** your hard drive.

7. Select the option to **Remove all partitions on this system**.

8. Continue through the next few screens (Partitioning, and Boot Loader Configuration). You should then see the Network Configuration screen. (If you get to the Firewall screen without seeing Network Configuration, Linux did not detect your NIC. If Linux detects a NIC in your server, it will ask you for Network Configuration. You need a network! If you do not see the Network Configuration screen, turn your server off. Check to see that your NIC is firmly seated in the PCI slot. When the server is moved around by our various groups, sometimes a card will become unseated from its slot. Make sure it is firmly seated, then turn your server back on, and try your installation again.)

   Check the checkbox so that your server will be configured using

   **DHCP**
9. You can configure a Firewall to protect your server from hackers. A firewall typically closes all but the minimal configuration of ports (see the table below for some sample well-known port numbers). To make things easy for your installation, select the radio button for

**No Firewall**

<table>
<thead>
<tr>
<th>Service Name</th>
<th>Port Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>ftp</td>
<td>21</td>
</tr>
<tr>
<td>telnet</td>
<td>23</td>
</tr>
<tr>
<td>smtp</td>
<td>25</td>
</tr>
<tr>
<td>DNS</td>
<td>53</td>
</tr>
<tr>
<td>HTTP</td>
<td>80</td>
</tr>
<tr>
<td>POP</td>
<td>110</td>
</tr>
<tr>
<td>login</td>
<td>513</td>
</tr>
</tbody>
</table>

ports 0-1023 are considered to be “well-known ports”

ports 1024-65535 are available for other uses

10. Continue through the next few screens. Set the time zone to Central time.

11. Specify a password for your root user. In Linux, the supervisor account is called root. Be sure to remember your root password!

12. It is now time to select individual packages to be installed. Accept all of the default packages, and add the following:

- FTP server add default options
- Network servers add default options
- Development tools add default options
- System tools add default options
- De-select Windows File server
- De-select Printing support

13. The installation will take about 30 minutes, as all files are copied from the CD to the hard disk, and as the server and its disk are configured. During this time, you can study, relax, visit your teammates, or do something else...

14. Insert CD #2 when instructed to do so.
15. Do not make a boot disk.

16. At some point, the installation will be complete. Remove the installation CD, then click the Exit button. The server will reboot.

**Post-installation configuration:**

1. Your server will boot to a login prompt. You rarely get to see an actual web server up close and personal. This is it!

   Using the server will be very similar to operating a Unix telnet session. First, log in as root, using the password that you specified during installation.

2. Install pico. Insert Installation CD #2 into the CD-ROM drive, and type the following:

   ```
   mount -t iso9660 /dev/cdrom /mnt/cdrom -o ro
   rpm -Uvh /mnt/cdrom/RedHat/RPMS/pine-*.rpm
   ```

   These commands “mount the CD drive”, then run Red Hat’s rpm (Red Hat Package Manager) program to install pico. The .rpm installation file is on the CD, in the /RedHat/RPMS directory. If you wanted to, you could get a directory listing of the CD just like a disk drive:

   ```
   cd /mnt/cdrom
   ls -l
   cd RedHat/RPMS
   ls -l
   ```

   To return to the disk, use the cd command:

   ```
   cd /
   ```

3. Your web server does not have a Fully Qualified Domain Name (such as mislab.cbi.msstate.edu), but during the boot process, it was assigned an IP address by the msstate DHCP server. Find out what your server’s IP address is:

   ```
   ifconfig
   ```

   This will give you two sections of output: one for your network communications, and one for localhost. You want the IP address in the first section. This address will begin with 130.18. Write down your server’s IP address here:

   __________ . __________ . __________ . __________
4. apache’s single configuration file is named httpd.conf, stored in /etc/httpd/conf. Let’s edit this file, if only to look at it:

```
cd /etc/httpd/conf
pico httpd.conf
```

This text file includes directives to the httpd program. The directives are used to configure your apache web server. A comment line begins with an octothorpe symbol (#).

In pico, you can use Ctrl-W to search for a string. Search for “ServerRoot”.

Ctrl-W
ServerRoot

This will search for the next occurrence of “ServerRoot”. The first few occurrences are in comment lines. Continue using Ctrl-W (you won’t have to type ServerRoot again; just press <Enter>) until you come to the actual ServerRoot directive. You will see:

ServerRoot “/etc/httpd”

As you can tell, this directive tells the apache program where the root of apache’s directory structure is. All of apache’s executables are in directories under /etc/httpd. Thus, you could move all of those executables, but you would need to change the value of this directive.

Search for the Listen directive. You can use this directive to specify an IP address and port number that your web server should listen to. Set this line to specify your IP address, and port 80, such as

```
Listen 130.18.87.159:80
```

You can have only one Listen directive. If there are two Listen directives in your httpd.conf file, be sure to comment one of them out.

Search for ServerAdmin. You can use this directive to specify an email address to which apache messages should be sent. The messages are rare, and are usually important when they are sent.

**Change your ServerAdmin to your email address.**

Search for ServerName. If you had an assigned Fully Qualified Domain Name (such as mislab.cbi.msstate.edu), you would put that here.

Search for DocumentRoot. This specifies the root directory under which default web pages will be stored (for the system, not for individual users).
Search for the Directory directive. This one is very important and is one of the most important configuration directives. Here, you specify features that you want apache to provide, specifying those features for individual directory structures. Normally, you have very restrictive features for the root directory, so you would seem something like:

```<Directory />
    Options FollowSymLinks
    AllowOverride None
</Directory>```

This basically says that no apache features are available in the root directory. Now you use additional Directory directives to allow features in subdirectories. The following is common:

```<Directory /home/*/public_html>
    Options ExecCGI Includes
    AllowOverride None
</Directory>```

Typically, user accounts are created under the /home directory. This directive allows two nonstandard features for any public_html directory that is under a user directory (that is under the /home directory): ExecCGI, which will allow the execution of CGI programs, and Includes, which will provide support for Server-Side Includes.

Add the above-listed 4-line `<Directory /home/*/public_html>` directive just below the `<Directory />` directive in your httpd.conf file.

Do not replace the existing Directory directive. Instead, add this directive underneath the existing one.

FYI only: On mislab, many user accounts are actually created in /home/users rather than in /home. For this reason, the following directive is in mislab’s httpd.conf configuration file (immediately after the previous one):

```<Directory /home/users/*/public_html>
    Options ExecCGI Includes
    AllowOverride None
</Directory>```

You can have many Directory directives, allowing you to configure a wide range of different features that are available in different directories on the server disk.
Search for the UserDir directive. This directive is used to indicate the default directory name under which user HTML files will be stored. By default, UserDir is set to *disabled*. As the instructions in the file say, you can comment out the line “UserDir disabled” and then uncomment the line that says “UserDir public_html” to allow access to individual user web pages.

**Comment out “UserDir disabled” and un-comment “UserDir public_html”**.

Search for the DirectoryIndex directive. This directive indicates a list of default file names that apache will search if a user does not specify a file name in a URL. If a user requests `http://misweb.cbi.msstate.edu`, for instance, with no file name, this directive will indicate which file names will be searched (and in which order). On misweb, the directive says:

```
DirectoryIndex   index.shtml   index.html   index.htm
```

**Change your DirectoryIndex to match the one shown above.**

Search for AddHandler. apache uses “handler modules” to handle certain features. cgi-script is a handler that will execute cgi scripts (duh). Use this directive to specify filename extensions for which cgi-script should be the handler. If you want cgi programs to end with a .cgi extension (such as formInput.cgi), use a command like:

```
AddHandler cgi-script .cgi
```

**Un-comment the .cgi AddHandler directive.**

Search for AddOutputFilter. This is similar to AddHandler (read the httpd.conf documentation), and is used to handle .shtml (server-side includes) files.

Search for ErrorDocument. You can use these directives to customize your server’s error messages.

As you can see, apache is a highly configurable system. You can customize your server by editing httpd.conf. Note that this configuration file is processed only when httpd is started, so if you edit the configuration file, you will need to reboot your server so that the edited configuration will be in effect.

After studying httpd.conf to your heart’s content, press Ctrl-X to exit pico. If you made any edits, you will have the option of either saving the edits, or not saving them.

5. The apache web server runs as a daemon process. The program name is httpd. Run that program to start your web server:

```
hpdp
```
6. Create a beginning web page for your server. By default, apache is configured to use /var/www/html as its “document root”. (This location is set with the DocumentRoot directive in httpd.conf.) Move to that directory, and use pico to create a small web page:

   cd /var/www/html
   pico index.html

7. Won’t it be amazing if you can access the web page that you just created from a client computer? On your client computer, use a web browser to try to connect to your server. Type the server’s IP address in your browser’s Location field. It should work!

   If you can access your web server from a browser, you are doing great!

8. Normally, you would want httpd to be run each time your server was booted. You can configure this (and several other similar programs) with:

   chkconfig httpd on
   chkconfig vsftpd on
   chkconfig telnet on

   (These program names all end with a d because they are daemon programs.) Now, httpd, ftp, and telnet will all be supported each time your server is booted.

9. Create a new user: (replace rpearson with your desired login name)

   useradd -d /home/rpearson rpearson

   This creates a new user with the login id of rpearson. The user’s home directory will be /home/rpearson.

10. Give the user a password:

    passwd rpearson

    As root user, you can change anyone’s password. There are also no restrictions on what password you give a user.

11. Reboot your server. Don’t just turn the power off, because Linux really likes to perform a graceful exit when it shuts down. Instead, type:

    reboot

    Only the root user may type this command. Well, other users may type it, but it will not reboot the server.
12. On your client, use your web browser to see if you can still go to your web server’s default web page (do a Shift-Reload to reload the page). If you can still go to the server’s web page, httpd must have been started during the reboot process!

13. Back on the server, log in with your newly created user and password. You will start off in the user’s root directory, which is /home/rpearson.

14. Create a public_html directory, move to that directory, and create an index.html file:

   mkdir public_html
   cd public_html
   pico index.html

15. Using your client web browser, access your new user’s web page. Assuming that your server is 130.18.87.159

   http://130.18.87.159/~rpearson

   You will probably get a Forbidden error. You need to check the permissions on your files and directories. Hopefully, someone in your group knows how to get a directory listing, read permission information, and change permission information. The following should fix your problem:

   cd ..../
   chmod 755 rpearson

   Now try to access your user’s web page again. Hopefully it will work this time!

16. Using your client’s ftp program, ftp to your new user account.

17. Using your client’s telnet program (or Token 2, which will be installed), telnet to your new user’s account.
**Final steps:** Experiment as you want, within reason!

In particular, if you have any CGI programming experience, you might want to get a CGI program and/or a server-side include running.

The `\data` directory on the Windows 98 client computer has two files that you can upload (via ftp) to your web server (upload these two files to the public_html directory of your user account). The two files are:

```
counter.shtml
counter.cgi
```

counter.shtml contains a server-side include which runs the perl program `counter.cgi`. You will, of course, need to set appropriate permissions on your files. As always, run `counter.cgi` from the command line to test it first. If your .shtml file encounters a problem, you can access apache’s two error files, which are both stored in `/etc/httpd/logs`:

```
/etc/httpd/logs/error_log
/etc/httpd/logs/suexec.log
```

Be sure to look in both of these files for error messages.

---

If you decide to shut down your server, don’t just turn the power off. Linux prefers to perform a graceful exit, so type the command:

```
shutdown now
```

When the shutdown process completes, you can turn the power off.
Assignment #15

Internet Concepts

1. Complete the following table with your computer’s information. If you are running a Windows machine, type the following command at the DOS prompt:

   `ipconfig /all | more`

   This runs the program `ipconfig.exe`, specifying the `/all` switch (which will cause the generation of more information than the standard `ipconfig`). The `|` character “pipes” the output of `ipconfig` to the `more` command, which will pause your output screen by screen.

   (In older versions of Windows, you would run `winipcfg`. In Linus, run `ifconfig`.)

<table>
<thead>
<tr>
<th></th>
<th>Your value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical address</td>
<td></td>
</tr>
<tr>
<td>DHCP enabled</td>
<td></td>
</tr>
<tr>
<td>IP address</td>
<td></td>
</tr>
<tr>
<td>Subnet mask</td>
<td></td>
</tr>
<tr>
<td>Default gateway</td>
<td></td>
</tr>
<tr>
<td>DHCP server</td>
<td></td>
</tr>
<tr>
<td>Primary DNS server</td>
<td></td>
</tr>
<tr>
<td>Secondary DNS server</td>
<td></td>
</tr>
<tr>
<td>Tertiary DNS server</td>
<td></td>
</tr>
</tbody>
</table>

2. Based on the information from the table above, how many bits are in your network address?

   What is your IP address, in binary?

   What is your network address, in binary?
What is your network address, in decimal?

What is your host address, in binary?

What is your host address, in decimal?

What is your physical address, in binary?

3. Use the Ping utility to get IP information about each of the following internet hosts. The program ping.exe should be available in c:\windows. Ping is used to verify that a specified network address is reachable, and to measure the delay that occurs when sending a datagram to that address and back (the time required for the round trip is called the "round-trip time"). To "ping" the address msstate.edu, for example, simply type:

    ping msstate.edu

Ping the following addresses to get the information to complete the table below.

<table>
<thead>
<tr>
<th>Host name</th>
<th>IP address</th>
<th>Class of IP address (A-C)</th>
<th>round-trip time</th>
</tr>
</thead>
<tbody>
<tr>
<td>msstate.edu</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mit.edu</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ibm.com</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>xerox.com</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sony.co.jp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>nike.com</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>futuresouth.com</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>belhaven.edu</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>microsoft.com</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. Use the TraceRt utility to get routing information about each of the following internet hosts. Assuming you are running Windows 95 or 98, the program tracert.exe should be available in c:\windows. TraceRt displays the IP address of the devices through which you go to reach a specified destination. Each line in the displayed output is a "hop".

<table>
<thead>
<tr>
<th>Host name</th>
<th>Number of hops to destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>msstate.edu</td>
<td></td>
</tr>
<tr>
<td>mit.edu</td>
<td></td>
</tr>
<tr>
<td>sony.co.jp</td>
<td></td>
</tr>
</tbody>
</table>

5. Find your hosts file. You can do this by moving to your root directory and using the dir command, such as:

   cd \n
dir hosts /s

(The /s switch tells the dir command to search all subdirectories.) Your hosts file might be in, for instance: c:\windows\system32\drivers\etc

Use an editor, such as edit, editPad, or notepad, to open your hosts file. Look at it. Any line that begins with an octothorpe character (#), is a comment line. Any other line consists of two parts:

   an IP address    a FQDN

You probably have a line that says:

   127.0.0.1    localhost

Add the following line:

   130.18.86.47  grades

Save the file.

Get into your web browser and type grades in the Location field. Your browser will read your hosts file, resolve grades to 130.18.86.47, then send a request for 130.18.86.47's default web page (130.18.86.47 is, of course, misweb).

Did it work?
6. In your Windows interface, open Control Panel, then Network Connections. You will see one or more listed network connections, such as “Wireless Network Connection” or “Local Area Connection”. The Status of each connection will be shown, such as “Enabled” or “Network cable unplugged”.

Right-click on one of your Network Connections, then select Properties from the pop-up menu.

You will see a list entitled “This connection uses the following items”, followed by a list of protocols or services that the connection uses. Scroll down to find TCP/IP on that list.

Click on TCP/IP to highlight it, then click the Properties button You will immediately see two of the most useful TCP/IP configuration items.

Does your computer obtain its IP address automatically (via DHCP), or have you assigned it a static address?

Does your computer obtain the addresses of its DNS servers automatically (via DHCP), or have you assigned static addresses?

You can use these options to configure your TCP/IP information. Let me tell you a story about how this can be useful. I used to have my home computer to obtain its DNS server addresses automatically. It retrieved two addresses (automatically) from my ISP each time I booted. Once, my DSL access seemed to be down. All day. I could not access any web sites. After several hours of waiting, I decided to try to specify an IP address of a server rather than a FQDN. It worked! This was good evidence that my DSL connection was NOT down -- the problem was somewhere within DNS -- I could not resolve a FQDN to an IP address. Since both my primary and secondary DNS servers both belonged to my ISP, and they apparently were experienced DNS problems, I could use FQDNs.

I now have that computer configured differently. Rather than “obtaining DNS server information automatically”, I have assigned static DNS server addresses. I listed my ISP’s server as my primary DNS server address, and MSU’s DNS server (130.18.80.12) as my secondary DNS server address. This way, if my ISP experiences DNS problems, my computer will go to MSU for backup assistance. This has worked beautifully!

Click on the Cancel button and close windows to complete this assignment.