MODULE 01

BASICS

PREREQUISITES: NONE. ONE TERM OF COLLEGE-LEVEL PHYSICS IS HELPFUL.

OUTLINE OF MODULE 01:

What you will learn about in this Module:
Basic Analog Circuits, Components, and Introduction to Integrated Circuits
Ohm's Law and other useful stuff
Passive components (mostly resistors and capacitors)
Discrete active components
Linear (analog) integrated circuits, Brief Overview
Digital ICs, Brief Overview
Identification of electronic components
Packages (basics), Pin numbering, Manufacturer ID
Identifying marks (resistors & capacitors)
How to draw a Schematic Diagram of an electronic circuit
Internet resources: datasheets, samples, application notes…

What you will build in the lab:
Nothing yet, sorry. That starts with the next module. You will do some simple exercises for identifying parts later in this module.

INTRODUCTION:

The purpose of this course is not for me to teach you everything about electronics…I'm far too busy and self-involved for that. The objective of this course is: for YOU to learn how to figure out electronics for yourself. This is exactly how I learned electronics. I will show you where to find resources on the web, and then I will suggest simple circuits for you to build in the laboratory. The circuits will use very common, readily available, and inexpensive components. Here at the University of Michigan I will provide a laboratory for your convenience, with all the necessary components in nicely labeled plastic drawers, but you can do this entirely by yourself if you happen to be stranded in some isolated technologically-impaired place, like Madagascar. All you need is an internet connection and a credit card.

To begin with, you will need to get a copy of the Art of Electronics (by Horowitz and Hill). From here on I will refer to this book as "H&H". In keeping with H&H, this course will emphasize practical experience first, followed by theory later. The Modules in this course will make frequent reference to the Second Addition of H&H. Every electronics nerd that I have ever met has a copy of H&H on his milk-crate-and-plywood shelf.

Electronics has become so standardized that it is a lot like making things from simple building blocks. Many very useful circuits are put together into collections called "cook books". Once you get the basic terminology figured out, you can find a cook book example for almost any imaginable circuit, for free, on the web.

One important note: We will cover a huge range of areas within the general field of "electronics" in this course. We will only touch on the most introductory material

so that you can get a sense for what can be done in each area, and so that you have a starting point if you want to learn more. Essentially, each module could be thought of as a separate field of specialization. So, when reading the material for each module you should go through the reading list quickly, browsing through each of the topics that are covered. Then you should go back and carefully read any sections that you find particularly interesting. Sometimes I will point out topics that are particularly important, and you should also study those closely. Everything else is optional. You will probably develop an interest in several topics later when you are confronted with a practical problem that draws on that area.

READINGS FROM HOROWITZ AND HILL (H&H): *ART OF ELECTRONICS*

Throughout this course we will be reading from Horowitz and Hill, second edition (H&H). In each module, readings will be assigned. You will notice that occasionally the same chapters are assigned as reading for different modules. This is because the material is important to several modules, and a quick refresher never hurt anyone.

If you have nothing better to do, read all of Chapter 1, otherwise just read:
Intro, 1.01-1.05, 1.07-1.14, 1.16-1.18, 1.23-1.31, 1.34
Focus your attention on: Ohm's Law, Kirchhoff's current law, Prefixes (pg 3), resistors, voltage dividers, Thevenin equivalent circuits, capacitors, RC circuits.
Appendix C: Resistor Color Code, 5% resistors
Appendix D: Precision Resistors
Appendix E: How to draw Schematic Diagrams
Appendix J: IC prefixes and markings (read this carefully!)
Appendix K: Datasheets (just glance at this…you will see plenty later on)

ADDITIONAL READINGS:

We will use a simple program to draw schematics and to design printed circuit boards for subsequent modules in this course. This program is available for FREE on the internet. Go to www.expresspcb.com and download their free software for your computer, or just use the software that is already loaded on the computer in the circuits lab. When you install this software there will be two components:

ExpressPCB: This is used to design the printed circuit board (PCB) that you can solder components onto. The software is free, and you can design boards for free, but if you actually want the boards made to your design you have to pay for them over the internet. Costs for this typically range from bout $65 to $120 for two or three small identical PCBs. We'll look at this in more detail in later modules.

ExpressSCH: This is the software we will use for drawing schematic diagrams of circuits. It is simple to use, very flexible, and FREE. You can link it to the ExpressPCB software to help you design your PCB after you have drawn your circuit if you want to. Download and install this software (already installed on our lab computer). Open ExpressSCH, click on HELP and read the ExpressSCH Users Manual, which is only about 17 pages long.

INTERNET RESEARCH:

You will learn to use the available internet resources for your electronic designs. The internet has a huge amount of information on electronics: parts specs and data sheets, on-line vendors, design Ideas and projects, and lots of other stuff.

Begin by going to IC Master (www.icmaster.com). You will need to register to use the site, but it is free.

Exercise #1: Use the IC Master search engine. How many different companies make the following integrated circuit chips, and what is the function or type of each chip:

	How many	What is it?
LM324	_____	_____
74HC541	_____	_____
74HC14	_____	_____

Notes: You will probably not know yet what these ICs do, but at least you can find information about them on the web. Also, there may be extra alpha-numeric characters in front of or behind each part designation. In some cases the additional characters signify a subclass of that part, but in some cases it means a completely different component. You will understand this better in subsequent Modules.

Exercise #2: There are hundreds of manufacturers of electronic components. Generally for this course we will use only a few of the major ones:

National Semiconductor, Texas Instruments (Burr Brown), Motorola, Maxim-ic (Dallas Semiconductor), Microchip

You should find the home pages of these manufacturers and bookmark them. You will be using their web sites throughout the remainder of this course, so you should get used to navigating them.

Which of the above manufacturers produces microcontroller ICs?
_____

SELF QUIZ

1: Sketch the outline of an integrated circuit chip, 14-pin DIP, show the "Pin 1" identifier mark, and clearly number all 14 pins:

2: What the heck is an LM7805? (Hint, use the Internet…it is a common integrated circuit)

3: Which vendor sells more types of operational amplifiers?
   a) Newark (newark.com)
   b) Mouser (mouser.com)
   c) DigiKey (digikey.com)

4: Which of the above vendors has the best price on the following integrated circuit: LM324A (14-pin plastic DIP package) for a quantity of 1. _____
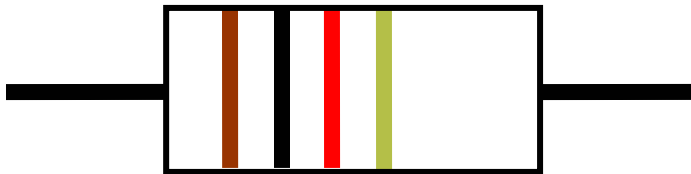
5: The resistor in the above diagram has 4 color bands (brown, black, red, gold). What is the resistance (and the tolerance value) of this resistor. _____

6: What color bands would this resistor have if it were a 470 kΩ, 2% resistor? _____ _____ _____ _____

7: You will sometimes need to connect passive components in parallel and series to get the desired value of capacitance or resistance, or in some cases components will naturally be arranged this way, and you will need to be able to calculate the equivalent resistance or capacitance. Draw a schematic to show how you would do the following:
    Use three 1MΩ resistors to make: a 3MΩ resistor; a 1.5 MΩ resistor; a 333kΩ resistor

    Use two 1µF capacitors to make: a 2µF capacitor; a 500nF capacitor

PLEASE ANSWER THE ABOVE QUESTIONS AND E-MAIL TO THE INSTRUCTOR
"I have neither given nor received aid on this examination, nor have I concealed any violation of the Honor Code"

            X_____

LABORATORY PROJECTS

1- Design a voltage divider using two or three resistors that will cut a 15 volt supply voltage down to 5 volts with respect to ground. The total current flowing through the circuit must not exceed 5 mA. Use standard resistor values for 5% resistors (see H&H Appendix C).

2. Place all of the drawings for this module into a single schematic using ExpressSCH.

3. Using the finished schematic diagram that you just drew with ExpressSCH, paste this diagram into a new Word document (or a graphics program):

Within ExpressSCH: EDIT → Copy Schematic Bitmap to the clipboard
Open Word (or equivalent, or a graphics program) and paste in the bitmap.

For the remainder of this course you will be asked to draw and hand in schematics for each module. You can do this any number of ways:

Attach the finished ExpressSCH file to an e-mail and send it to the instructor.
or:
Cut and paste the bitmap image of the schematic into Word, etc.,
and
Convert into a PDF file and send it to the instructor in PDF format.

FEEDBACK

Was this Module useful and informative?

_____

Is there a topic that should get more or better coverage?

_____

In what way can this Module be improved:

Content: _____

Depth of Coverage: _____

Style: _____

Any additional comments that will help us to improve this course:

_____

_____

_____

If you prefer, you may e-mail comments directly to Bob Dennis: yoda@umich.edu