Appendix E.1. Classroom Assignments at George School

E.1.

Here are the classroom assignments that are given to each of the *Computer Programming & Robotics* classes at George School. Most of assignments involve reading some portion of a chapter in this textbook and solving some of the **Challenge Problems**, which are found at the end of each chapter. No timeline is given for the assignments because ours is a student-driven, self-paced course, allowing students to follow a pace that suits their needs and interests.

Generally speaking, students should complete *Volume One* of the text in **12 weeks** and *Volume Two* in **10 weeks**. (See *Appendix E Section 2* for details about the timeline for our projects.)

E.1.1. First Monday Introductions

- Welcome and introductions
- Assign computers, robots, and toolboxes to each student.
    - Record the device numbers for each student
    - Which students will bring their own computer, and which will use a school machine?
- Log into computers. This may take a while. Remember your laptop number!
- Create e-mail distribution list
- Point out location of the Robotics folder/files on the class OneDrives
- Have students decide what kind of textbook they want. Here are the hard-copy options:
    - Black & White, spiral bound: $22.56
    - Color, perfect bound: $32.39
    - If you are unable to afford the book or if you must have an e-copy of the text, talk to Chris.
- Otherwise, there is nothing else they need to purchase for the class. (Some supplies will be given to you tomorrow, and will be charged to your account.)
    - Students may wish to buy a small notebook that can be stored in the bottom of the toolbox. (Have an example on hand to display.) Notebooks are often used by programmers to work out their algorithms on paper before coding them into the computer!
- Point out location of syllabus on LMS.
    - Discuss syllabus and safety concerns.
- Wish to help build GS's new Prusa i3 3D printers? Show of hands:
        - Friday afternoons (probably multiple days):
        - Sunday (multiple days or one long day?):
- Have students think about if they want purchase a Prusa i3 3D printer:
    - Want to buy one? Here are the links:
        - Plastic bed with thru-holes:
            - http://www.ebay.com/itm/111819683316?_trksid=p2057872.m2749.l2649&ssPageName=STRK%3AMEBIDX%3AIT
        - Metal bed with tapped holes:
            - http://www.ebay.com/itm/3D-DIY-Printer-Self-assembly-Full-Acrylic-Reprap-Prusa-Aurora-i3-With-LCD-AW/111975733036?_trksid=p2047675.c100005.m1851&_trkparms=aid%3D222007%26al

go%3DSIC.MBE%26ao%3D2%26asc%3D37470%26meid%3D697016a057434698a478e4215ebc493b%26pid%3D100005%26rk%3D2%26rkt%3D6%26sd%3D301960806073

- Mark Haber's:
  - http://www.ebay.com/itm/2016-Upgraded-Full-Quality-High-Precision-Reprap-Prusa-i3-DIY-3d-Printer-US/152180290912?_trksid=p3693.c100102.m2452&_trkparms=ao%3D1%26asc%3D20140212121249%26meid%3Dce0dc31e2f594dafa7cd3991660899c0%26pid%3D100102%26

- Untested sellers:
  - http://www.ebay.com/itm/3D-DIY-Printer-Self-assembly-Full-Acrylic-Reprap-Prusa-Aurora-i3-With-LCD/282011245812?_trksid=p2047675.c100005.m1851&_trkparms=aid%3D222007%26algo%3DSIC.MBE%26ao%3D1%26asc%3D37183%26meid%3D6113272a41064cf1a6a8a9a7d2d93689%26pid%3D100005%26rk%3D1%26rkt%3D6%26sd%3D111819683316
  - http://www.ebay.com/itm/3D-Printer-Kit-Prusa-i3-DIY-High-Accuracy-CNC-Self-Assembly-Printing-Machine-/172153356065?hash=item281523bf21:g:wicAAOSw3xJXpC87
  -

- Point out homework
- Have fun with some Robot Demos, such as:
  - YouTube playlist from last year's Open House (see Pages on Canvas)
  - LCD output
  - Student-made LED screen (thanks, Ellie Clermont!)
  - Line Following 3D-Printed Robot
  - Robosapien
  - IR Card Swipe
  - Fingerprint Reader
  - RGB LEDs with Bluetooth activation
  - MP3 Player
  - Kynex robot
  - ESRA
  - Tank
  - 3D Printer
  - etc
- **Homework:**
  - Read the course syllabus on Canvas >> Files >> Syllabus & Course Info
  - If you plan to use your own computer, download and install the following:
    - **Arduino/Teensy Software**
      - Read Chapter 1 Section 4 (pages 4-8) and download and follow the steps to install the necessary Arduino and Teensyduino software. You can find the book in Files >> PC&R Volume 1 Chapters.
  - If you plan to use your own computer, download and install the following before October:
    - **SketchUp Software**
      - Download SketchUp (http://www.sketchup.com/download). Select "Educational Use".
      - SketchUp Make is free
      - Download and install the SketchUp STL plugin. (ITS may not yet have installed this on all machines.) You can get this in the Files section on Canvas:
    - **Repetier 3D Printer Software**
      - Download and install the Repetier-Host from https://www.repetier.com/.
      - This is a free download, but I recommend supporting this excellent piece of software with a small donation. It is worth it!
    - **MakerBot 3D Printer Software**
      - Download and install the MakerBot Makerware from http://www.makerbot.com/desktop.
      - Select MakerBot Replicator 2 (not 2X)
    - **Express PCB (printed circuit board) CAD Software**
      - Download and install ExpressPCB from https://www.expresspcb.com/free-cad-software/.
      - It is a free download

- You do **not** need to install ExpressSCH

❖ (*Optional*) For those interested in building a resume, you may want to create your own "academic/professional" YouTube or other video-posting channel. You can post videos of your robotic projects here, so parents, friends, college admission people, and future employers may hit on this page.

❖ (*Optional*) Create a Twitter account and follow GSRobotics

E.1.2. Day 2 Beginnings

- Any questions about the syllabus?
- Log into computers. This may take a while. Remember your laptop number!
- Create folders for the following projects:
  - Arduino or Teensy sketches (robot apps)
  - SketchUp designs for 3D printing
  - ExpressPCB circuit board designs
- Distribute and verify last year's out "Robot distribution (Last day of school).docx" document.
- Pass out toolboxes, which belong to George School. They should contain:
  - Robot parts including chassis, motors, wheels, standoffs, spacers, hardware, and Velcro strip
  - Large and small hex wrenches
  - Screwdriver multi-tool
  - Sensors and Passives including Sharp IR, Sonic (3), LED circuits (2)
  - Etc.
- Pass out the following, which have been purchased by students:
  - Teensy 3.2 microcontroller
  - Teensy 3.2 Pinout Card
  - Programming cable
- In a couple of weeks, pass out the rest of the equipment purchased by the students:
  - PRT3 Motherboard kit
  - Batteries and battery pack
  - Electronics kit from Jameco
  - Connecting wires (male-male, female-female, and male-female)
- Download and install the SketchUp STL plugin. (ITS may not yet have installed this on the school machines.) You can get this either in the bookmark or handout sections on the LMS. (Go to our class page and click on "3D Printing".)

E.1.3. Chapter 1 – Introduction to Physical Computing

- **Intermediate students:**
  - Carefully read the all but Section 7 (Details about Microcontrollers for *Serious* Programmers) of *Chapter 1: Introduction to Physical Computing* and perform all the steps with your own microcontroller.
  - **Solve the following Challenge Problems.**
    - 1, 2, 6, 7, 8, 9, 10, 11, 13
    - For Problems 1-9, record your answers on paper or type the answers as coded output. Turn in these answers to the instructor.
    - Have the instructor *visually check* your solution code for Problems 10-13 before proceeding to the next chapter.

- **Intensive students:**
  - Carefully read all of *Chapter 1: Introduction to Physical Computing* and perform all the steps with your own microcontroller.
  - **Solve the following Challenge Problems.**
    - 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13
    - *Optional Bonus*: 12
    - For Problems 1-9, record your answers on paper or type the answers as coded output. Turn in these answers to the instructor.
    - Have the instructor *visually check* your solution code for Problems 10-13 before proceeding to the next chapter.

E.1.4. Chapter 2 – Serial Output and Intro to Functions

- Carefully read *Chapter 2: Serial Output and Introduction to Functions* and perform all the steps with your own microcontroller.
- Carefully read how to set up your Challenge Problem coded sketch, which is found on the first page of the Challenge Problems section on page xxx. You should follow this template example for each of your Challenge Problem sets.
- **Intermediate students:**
  - **Solve the following Challenge Problems.**
    - 1, 2, 7, 8, 9, 11
    - *Optional Bonus*: 5
    - For Problems 1, 7, and 8, record your answers on paper or type the answers as coded output. Turn in these answers to the instructor.
    - Have the instructor *visually check* your solution code for your problems before proceeding to the next chapter.
- **Intensive students:**
  - **Solve the following Challenge Problems.**
    - 1, 4, 7, 8, 9, 10, 11, 12
    - *Optional Bonus*: 5
    - For Problems 1, 7, and 8, record your answers on paper or type the answers as coded output. Turn in these answers to the instructor.
    - Have the instructor *visually check* your solution code for your problems before proceeding to the next chapter.

E.1.5. Chapter 3 – Data Types, Variables, and Constants

- **All students:**
  - Carefully read *Chapter 3: Data Types, Variables, and Constants* and perform all the steps with your own microcontroller.
- **Intermediate students:**
  - **Solve the following Challenge Problems.**
    - 3, 5, 7, 8, 9, 10, 11, 12, 17, 20, 21, 22, 23, (24 or 25)
    - For any problems that ask for a *predicted* outcome (Problems 6-25), record your predicted output on the Predictive Worksheet or on paper or as a comment in the Arduino IDE. Do **not**, however, enter the code into the IDE and compile it. I want to see if you can *deduce* what the outcome will be, not *read* what the outcome is!
    - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

- **Intensive students:**
  - **Solve the following Challenge Problems.**
    - 1, 2, 3, 5, 7, 8, 9, 10, 11, 12, 17, 20, 21, 22, 23, 25, 26.b (The **`MJ2()`** function)
    - For any problems that ask for a *predicted* outcome (Problems 6-25), record your predicted output on the Predictive Worksheet or on paper or as a comment in the Arduino IDE. Do **not**, however, enter the code into the IDE and compile it. I want to see if you can *deduce* what the outcome will be, not *read* what the outcome is!
    - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

E.1.6. Chapter 4 – Arithmetic and Rounding

- Read *Appendix A: Helpful Programming Hints* and follow these guidelines when writing solutions to the Challenge Problems at the end of each chapter.
- **Intermediate Students:**
  - Carefully **read** *Chapter 4: Computer Arithmetic and Rounding*. You may skip *Section 3: Modulo and Integer Division*. **Perform** all the steps with your own microcontroller.
  - **Solve the following Challenge Problems.**
    - 2a-e, 3, 5, 13, 16, 31, 41.b
    - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.
- **Intensive Students:**
  - Carefully **read** *Chapter 4: Computer Arithmetic and Rounding* and **perform** all the steps with your own microcontroller.
  - **Solve the following Challenge Problems.**
    - 2, 3, 4, 7, 14, 17, 31, 41.b, 43
    - *Optional Bonus*: 8
    - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.
- **All Students:** Take the **Chapters 1-4 Progress Quiz**. Ask your teacher for the quiz materials.

E.1.7. Chapter 5 – Functions and Arguments

- Carefully read *Chapter 5: Functions with Arguments* and perform all the steps with your own microcontroller.
- **Intermediate Students:**
  - **Solve the following Challenge Problems.**
    - 1, 2, 4, 5, 11, 21
    - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.
- **Intensive Students:**
  - **Solve the following Challenge Problems.**
    - 1, 2, 4, 7, 14, 22, 34
    - *Optional Bonus*: 8 (This is a difficult problem, with many possible solutions.)
    - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

E.1.8. Chapter 6 – Serial Keyboard Input and Modular Programming

- **All Students:**
  - Create a folder named "**SKIF Module**" where you normally store your program files. Next, navigate your browser to **Canvas >> Files >> Modules for GS Students**, and copy the "SKIF.ino" file into the **SKIF Module** folder you just created. Having this module will save you from having to enter all the SKIF commands by hand.
  - Quickly **skim** *Chapter 6: Serial Keyboard Input and Modular Programs* and **learn** how to make use of the SKIF commands that are discussed in the chapter. The SKIF commands that are discussed within the chapter are given to you in the SKIF module, as explained in the above step. When the book asks you to build the SKIF module, I recommend that you simply use the provided module that you downloaded, rather than typing in the code by hand.
- **Intermediate Students:**
  - **Solve the following Challenge Problems.**
    - 1, 2, 3 (Redo #5 in Chapter 4), 4
    - Turn in your work via a Canvas Assignment on the LMS, **and** *have your instructor grade your solution code before proceeding*.
- **Intensive Students:**
  - **Solve the following Challenge Problems.**
    - 1, 2, 3 (Redo #17 and 41.b in Chapter 4), 4
    - Turn in your work via a Canvas Assignment on the LMS, **and** *have your instructor grade your solution code before proceeding*.
- **All Students:** Take the **Chapters 5 & 6 Progress Quiz**. Ask your teacher for the quiz materials.

E.1.9. Chapter 7 – Advanced Mathematics

- **Intermediate students** can skip this chapter.
- **Intensive students should:**
  - Carefully **read** *Chapter 7: Advanced Mathematics* and **perform** all the steps with your own microcontroller.
  - **Solve the following Challenge Problems.**
    - 8, 31
    - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

E.1.10. Chapter 8 – Random Numbers

- **All Students:**
  - Create a folder named "**Random Module**" where you normally store your program files. Next, navigate your browser to **Canvas >> Files >> Modules for GS Students**, and copy the "randomModule.ino" file into the **Random Module** folder you just created. Having this module will save you from having to enter all the random number generator commands by hand.
- **Intermediate students:**
  - Quickly **skim** *Chapter 8: The Random Number Generator* and **learn** how to make use of the random number generator commands that are discussed in the chapter. The random number commands that are discussed within the chapter are given to you in the randomModule module, as explained above. When the book asks you to build the random number module, I recommend that you simply use the provided module that you downloaded, rather than typing in the code by hand.
  - **Solve the following Challenge Problems.**
    - 3, 6, 8, 12 (Redo #31 in Chapter 4)

        - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

- **Intensive students:**
    - Carefully **read** *Chapter 8: The Random Number Generator* and **perform** all the steps with your own microcontroller. The random number commands that are discussed within the chapter are given to you in the randomModule module, as explained above. When the book asks you to build the random number module, I recommend that you simply use the provided module that you downloaded, rather than typing in the code by hand.
    - **Solve the following Challenge Problems.**
        - 3, 4, 7, 12 (Redo #43 in Chapter 4), 16
        - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

E.1.11. Chapter 9 – If-Then Logic Statements

- **Together as a class:**
    - Watch the "Sorcerer's Apprentice" portion of the Disney animated musical, *Fantasia*, which occurs 28 minutes, 48 seconds after the start of the film. (The clip runs for about ten minutes.) Watch it with an eye of a computer programmer. Specifically think about Mickey Mouse's actions as a computer program with instructions were too open-ended. What restrictions should he have imposed on the brooms with logic statements?

- **Intermediate students:**
    - Carefully read *Chapter 9: If-Then and Switch-Case Logic Statements* and perform all the steps with your own microcontroller. You may skip Example 7d, Demonstration 4, and the sections in the chapter that cover truth tables.
    - **Solve the following Challenge Problems.**
        - 1, 2, 3, 4, 5, 6, 7, 8, 14, 15. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
        - 19 (use an **if-else** block), 19 (use a **switch-case** block), 29
        - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

- **Intensive students:**
    - Carefully read *Chapter 9: If-Then and Switch-Case Logic Statements* and perform all the steps with your own microcontroller.
    - **Solve the following Challenge Problems.**
        - 1 – 15. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
        - 19 (use an **if-else** block), 19 (use a **switch-case** block), 22, 29
        - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

- **All Students:** Take the **Chapters 8 & 9 Progress Quiz**. Ask your teacher for the quiz materials.

E.1.12. Chapter 10 – While- and Do-While Loops

- **Intermediate students:**
    - Carefully read Chapter 10: While- and Do-While Loops and perform all the steps with your own microcontroller. You may skip the last two sections (Sections 5 and 6) on using real time clocks, and series and sequences.

- **Solve the following Challenge Problems.**
  - 1 – 16. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
  - 21, 28, 29 (turn in your spreadsheet along with your code on the LMS), 36, 42, 47
  - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.
  - Other problems worth your consideration – not to be graded: 25, 47

- **Intensive students:**
  - Carefully read Chapter 10: While- and Do-While Loops and perform all the steps with your own microcontroller. You may skip the last section (Section 6) on series and sequences.
  - **Solve the following Challenge Problems.**
    - 1 – 16. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
    - 21, 23, 28, 29 (turn in your spreadsheet along with your code on the LMS), 43, 45, 50, 62
    - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.
    - Other problems worth your consideration – not to be graded: 25, 40, 46, 51

E.1.13. Chapter 11 – For-Loops

- **Intermediate students:**
  - Carefully read Chapter 11: For-Loops and perform all the steps with your own microcontroller.
  - **Solve the following Challenge Problems.**
    - 1 – 16. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
    - 25, 27, 40, 43, 52, 53
    - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

- **Intensive students:**
  - Carefully read Chapter 11: For-Loops and perform all the steps with your own microcontroller.
  - **Solve the following Challenge Problems.**
    - 1 – 16. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
    - 25, 27, 40, 43, 45, 52, 53, 56
    - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

- **All Students:** Take the **Chapters 10 & 11 Progress Quiz**. Ask your teacher for the quiz materials.

E.1.14. Vol 2 Chapter 12 - Going Forward with Physical Computing

- **All students:**
  - Carefully read Chapter 12, Section 2, and perform all the steps with your own microcontroller. Specifically, read the following sub-sections:
    - The Patton Robotics PRT3 Motherboard
    - How to Build and Solder the PRT3 Motherboard
    - The Patton Robotics OneBot Mobile Robot
  - **Solve the following Challenge Problems.**
    - 14, 15, 16, 17

E.1.15. Chapter 13 – Vol 2 Chapter 13 - An Intro to Electronics and Getting to Know the PRT3 Motherboard

- If you haven't done this yet, **solder** your **PRT3** motherboard
  - Read how to solder the board and how to set the jumpers here: http://pattonrobotics.com/products/patton-robotics-teensy-motherboard-kit
- If you haven't done this yet, build your **OneBot Robot**
  - Read how to build the robot here: http://pattonrobotics.com/products/onebot-basic-complete
- If you haven't done this yet, **label** your six NiMH batteries and **charge** them.
- **Intermediate students:**
  - Carefully read *Vol 2 Chapter 13 - An Intro to Electronics and Getting to Know the PRT3 Motherboards* and perform all the steps with your own microcontroller.
  - **Solve the following Challenge Problems.**
    - If you haven't already, do Challenge Problems 1, 2, 3, 4
    - 5, 6, 8, 11, 14-16, 19, 20, 21-24, 27
    - You do not need to turn in these problems, but you should see your instructor for the answers. This material will be covered on a Progress Quiz.
- **Intensive students:**
  - Carefully read *Vol 2 Chapter 13 - An Intro to Electronics and Getting to Know the PRT3 Motherboards* and perform all the steps with your own microcontroller.
  - **Solve the following Challenge Problems.**
    - If you haven't already, do Challenge Problems 1, 2, 3, 4
    - 5-8, 11, 14-19, 21-24, 27-28
    - You do not need to turn in these problems, but you should see your instructor for the answers. This material will be covered on a Progress Quiz.

E.1.16. Chapter 14 – Getting Started with Circuits

- **Intermediate students:**
  - Carefully read all but *Section 5* (Ohm's Law) from *Vol 2 Chapter 14 – Getting Started with Circuits* and perform all the steps with your own microcontroller.
  - **Solve the following Challenge Problems.**
    - 2, 5, 6, 10, 14, 16-18, 20-24, 33
    - You do not need to turn in these problems, but you should see your instructor for the answers. This material will be covered on a Progress Quiz.
- **Intensive students:**
  - Carefully read *Vol 2 Chapter 14 – Getting Started with Circuits* and perform all the steps with your own microcontroller.
  - **Solve the following Challenge Problems.**
    - 1-3, 5, 6, 10, 14-18, 20-24, 27, 29-31, 33, 34, 38, 39
    - You do not need to turn in these problems, but you should see your instructor for the answers. This material will be covered on a Progress Quiz.

E.1.17. Chapter 15 – Creating Sound and Light with a Breadboard and PRT3 as the Voltage Source

- **Intermediate students:**
    - Carefully read all of *Vol 2 Chapter 14 – Creating Sound and Light with a Breadboard and PRT3 as the Voltage Source* and perform all the steps with your own microcontroller.
    - **Solve the following Challenge Problems.**
        - 4, 6, 8, 18, 20 (use three 390Ω series resistors), 23
        - *Optional Bonus:* 10 (Chris needs an image of this for his book. Do the problem and be famous!)
        - You do not need to turn in these problems, but you should see your instructor for the answers. This material will be covered on a Progress Quiz.
- **Intensive students:**
    - Carefully read all of *Vol 2 Chapter 14 – Creating Sound and Light with a Breadboard and PRT3 as the Voltage Source* and perform all the steps with your own microcontroller.
    - **Solve the following Challenge Problems.**
        - 4, 6, 8, 11, 18-20 (Use *Appendix H* to calculate the values of your three series resistors), 23
        - *Optional Bonus:* 10 (Chris needs an image of this for his book. Do the problem and be famous!)
        - You do not need to turn in these problems, but you should see your instructor for the answers. This material will be covered on a Progress Quiz.