

## Engineering Design

### Electronics Final Project - Mini-Theremin musical “instrument”

Your assignment is to create an electronic musical instrument. You can find circuits, programs, and explanations for all the necessary elements of this project in Chapters 6-8 of the [What's a Microcontroller Student Guide](#), but you will need to combine many of these elements on your own, as you did with the pot-controllable LED flasher but more extensively. The following are the deliverables for the project:

#### Group Part

Deliverable	Due Date - A	Due Date – F	Points
Project Plan	F 12/6	M 12/9	10
Daily Project Log	Daily end of class	Daily end of class	1/day
Measure light	M 12/9	T 12/10	10
Control LED with light	M 12/9	T 12/10	15
Play a tune	W 12/11	W 12/11	10
Collect and analyze data*	Th 12/12	Th 12/12	10
Digital light meter*	F 12/13	M 12/16	15
Play scale with pot	F 12/13	M 12/16	15
Play scale with light	M 12/16	T 12/17	15
Play tunes on “instrument”	T 12/17	W 12/18	20
Final Delivery	W 12/18	Th 12/19	5

#### Individual Part

Personal PPR	W 12/18 8PM	Th 12/19 8PM	5
Post-Project Review	F 12/20 8PM	F 12/20 8PM	20
<b>Total</b>			<b>157</b>

\*May be completed by an individual or the group.

Due dates are at 3PM unless otherwise noted. There is a bonus of 10% on each deliverable (except the Project Log) for every full school day it is delivered in advance of the due date, and a 20% deduction for every full or part of a school day it is delivered past 3PM on the due date.

The project is scored out of 100; 157 points are possible, more with early delivery bonuses. You don't have to deliver all of them, or deliver them in order; you can devise any strategy you wish to get to an acceptable number of points for your team, perhaps with some “if time permits” options. Record your strategy on the Project Plan (see below).

You may take your electronics kit home if you wish, but if it doesn't come back because someone is sick, you do NOT get a replacement to use at school. You may NOT take the computers home.

Groups must complete group work ON THEIR OWN. You may share ideas, theories of operation, and other non-patentable and non-copyrightable work. PBasic programs, and all other written work must be completed by group members only. If you copy another group's program, or a significant portion of it, you are violating academic integrity. Each program must state the owner's copyright as usual, and include a citation of any programs in the text from which it was derived.

## **Project Management Deliverables**

### **Project Plan**

The EE Project Log assignment in Canvas has a link to the master copy of a Project Log. Fill it in as follows:

1. Enter the name of each member of your team in the columns that ask you to **enter name 1**, etc.
2. Break the project as a whole into at least 8 specific tasks. Each task must have:
  - a) Short task name (short, for use in the Project Log)
  - b) Description – what work will be done, and how you will know when the task is fully complete.
  - c) Person Responsible – who will make sure the task is completed on time. This should be ONE person. If more than one person is responsible, no one is.
  - d) Start date – the date that at least one person plans to start working on this task
  - e) End date – the date on which you are committed to complete it (3PM assumed)
  - f) Staffing – for each person in the team, enter how many hours you estimate they will work on the task in their column.
3. When you have completed the tasks, create a total line that totals the hours for each person, and the project as a whole. Check that no task accounts for more than 10% of the total. If one does, break it up into smaller tasks.

### **Daily Project Log**

The usual, with one difference from previous projects: the Task Name should be one of the ones from your Project Plan. Note that this means a team member may have more than one entry for a particular day, reflecting their work on different tasks.

As the work progresses, you may find that you neglected an important task in the plan, or that it would better reflect reality to re-organize your project into different tasks – combine some, split out others, etc. You're welcome to do this, but you'll need to explain what you did and why in your Post-Project Review (see below)

Remember to make your Work Done entry as specific as possible – what you actually accomplished as part of the task.

### **Final Delivery**

A final version of the Project Log spreadsheet. Indicate that you have completed this by sending a confirming email to MrH. No changes to the spreadsheet can be made after this email.

### **Personal PPR** *(the usual)*

## **Post-Project Review - Individual!**

The purpose of the Post-Project Review is to compare actual results of the project versus your original plans, and record what you have learned during the project that would allow you to complete a similar one in the future more efficiently and effectively. It should be a single, professional-quality Google doc, formatted to allow printing double-spaced.

It must include the following sections:

Executive Summary: 1-3 paragraphs summarizing the most important information in the following sections. (worth 10%)

Project Plan versus Actual Analysis: Compare your Project Plan to what actually happened during the project:

- Hours vs. planned: by task, by individual, and total
- Start and end dates vs. planned by task

Where there are differences of more than around 10%, you should present your best explanation for why they occurred. For example, if you underestimated labor hours, what assumptions did you make in coming up with your original estimate, and which of these turned out to be mistaken? One or more summary tables, graphs or charts with explanatory text is a good format. (30%)

Areas for Improvement: Having been through this project once, if you were to attempt a similar project in the future, what would you do differently? How you split up the labor? How you managed the work? What technology problems did you encounter, and how could you have avoided them? What decisions did you make that you'd like to have back? Would you do things in a different order? Summarize your "lessons learned": what you would be able to do more effectively the next time, and what recommendations you would make to the project teams of the next Engineering class to help them complete the project more quickly and effectively. *Note: "pick different partners" is not really helpful, as you had limited input into who they were. If you ended up working with someone who you DID have on your "want" list, and you wouldn't put them there again, why?* (30%)

Revised Project Plan: Knowing what you now know, and assuming you made the improvements you identified in the previous section, but you had lost all your programs and circuit diagrams, what would your Project Plan look like if you were starting the project today? Assume the same people on the project, and provide the plan as an embedded spreadsheet, along with an explanation of the differences from the original. (10%)

Professionalism counts for the final 20%. It's important that the document look clean, and "hang together". Text should be free of obvious grammatical and spelling errors; use the spell and grammar checkers! Drawings and figures should be embedded in the document. Don't get carried away with fonts and formatting, but it should have consistent section headers, paragraph styles, fonts, etc. and should look good if printed. Before you turn it in, ask yourself "would I give this to the person responsible for my next raise, or for even keeping me on the payroll?"

## **Technical Deliverables**

### **Measure Light**

Use an RC circuit and phototransistor to measure light intensity. Demonstrate reporting a range of at least 1000 from cupping your hand over the phototransistor to exposing it to the lighted Elmo stage. Make sure your .bs2 program is fully commented!

### **Control LED with Light**

Flash an LED approximately once per second to indicate the lowest light intensity measured above, gradually increasing to flashing so fast that it almost looks like it's fully turned on when on the lighted Elmo stage. Make sure your .bs2 program is fully commented!

### **Digital Light Meter**

Display the level of light measure using the 7-segment digital display, ranging from 0 at the darkest level to 9 at the Elmo stage. The increase should be approximately linear as you move your hand up and down. Make sure your .bs2 program is fully commented!

### **Collect and Analyze Data**

Collect at least 100 light measurement data points at 0.1 second intervals with the board "untethered" from the PC, and transfer this data and display this data on the PC after reconnecting it. Make sure your .bs2 programs are fully commented!

### **Play a Tune**

Play a recognizable tune on the piezo speaker. It must have least 6 different notes, at least 12 notes in total, and use at least 3 different durations using the piezo speaker. (For example, Deck the Halls through the first fa-la-la-la-la works). Make sure your .bs2 program is fully commented!

### **Play Scale with Pot**

Using the 10K pot, play an 8 note octave scale (do-re-mi-fa-sol-la-ti-do) by rotating the pot. Any major or minor key is fine. Make sure your .bs2 program is fully commented!

### **Play Scale with Light**

Use your hand, controlling the amount of light that reaches the phototransistor, to play an 8-note octave scale. Make sure your .bs2 program is fully commented!

### **Play Tunes on an "Instrument"**

Using whatever combination of 1 or 2 pushbuttons, 1 or 2 phototransistors, and 1 or 2 pots, create an "instrument" that you can use to play a tune (with some practice, of course). It doesn't have to be the same tune you used for the "Play a Tune" milestone, but it needs to meet the same

requirements. You can stick to notes on the major or minor scale, but chromatic notes (accidentals) will get you extra points! Describe the notes and durations your instrument plays.

Then play a short (different) tune specified by your teacher. This tune will use up to 8 notes of a major scale (although you can play it in minor if that's all your instrument supports. Tunes will be simple, like "Happy Birthday", "Twinkle, Twinkle", "Ode to Joy" (two lines), etc.