About This Course

In the Bytes and Beats course, students will learn the fundamentals of programming with MATLAB while making their own music with sensors. They will use MATLAB, the programming language used by scientists and engineers today to turn if-statements, for-loops, and functions into rhythms, melodies, and harmonies through an Arduino board and sensors.

Working with friends, students will compose and visualize their own music and invent their own symphonic creations. At the end of the course, students can take home their own electronics to continue fine-tuning their musical inventions.

No prior knowledge of programming or working with electronics is required.

Computer programming and musical concepts will be explored through various discussions, activities, lessons, and projects.

Learning Objectives

Computer Programming Concepts	
File Structure and Management	Students will create and use nested directories.
Computation and Calculation	Students will be able to execute single-line commands in the MATLAB **Command Window** for basic tasks and calculations: • Create variables • Create arrays • Execute functions • Read in and export data • Perform simple calculations to compute and manipulate data
Algorithms	Students will be able to identify and explain the steps used in a problem-solving process. Solve a problem using an algorithm. • What is an algorithm? Show an example? • Create a MATLAB script
Modularity of Code and Abstraction	Students will use models to simplify complex topics. They will be able to examine the output of a process to understand how data is changing so that they can identify patterns. Students will be able to repeat patterns found in code to create new code patterns with altered behavior.

Syntax	Students will learn how to write syntactically correct MATLAB code.
Visualization	Students will create visualizations of their musical sound waves.
Logical Control and Looping	Students will be able to create programs that automatically make decisions based on certain rules. Learn to create loops to deal with repetitive code.
Debugging	Students will learn how to identify and remove the sources of errors in their code.
Hardware Interface	Students will be able to interface with the hardware controller, program the controller for use with MATLAB, and check the controller for connectivity to MATLAB.

Musical Concepts	
Libraries	Students will have access to a library of sounds, be able to select the musical instrument they want, and be able to add their own custom sounds to the library.
Sounds	Students will understand what is sound and how it is created. They will be able to relate the properties of sounds to the properties of sound wave. They will identify pitch and loudness—the components of a musical sound.
Songs	Using the concepts of repetition and theme, students will combine musical sections and notes to create a melody. They will also have the option to record their voices to create a song.
Musical instrument	Students will create a custom musical instrument using MATLAB and some hardware.

Overview of the Week

Day 1	Day 2	Day 3	Day 4	Day 5
Activity: Ice Breaker (10 min.)	Lesson: Revisit Creating Array of Numbers (10 min.)	Lesson: For Loops (40+ min)	Lesson: Creating a Sound File for Silence (20 min.)	Activity: Using a Painted Sensor as a Musical Instrument (45+ min.)
Discussion: Sound and Music (10 min.)	Lesson: Indexing Numeric Arrays (10 min.)	Lesson: Practicing For Loops (optional) (15 min.)	Lesson – Concatenating Sound Files (20+ minutes)	Activity: Recording Your Voice with MATLAB (30 min.)
Activity: Music Has Rhythm and Volume (10 min.)	Lesson: Doing Math with Vectors (10 min.)	Activity: Creating Your Own Musical Instrument! – A Theremin (60 min.)	Lesson – Adding Sound Files (20+ minutes)	Activity: Preparing for a Music Concert! (60+ min.)
Activity: Sound is Made by Vibrating Air (10 min.)	Lesson: Saving Variables from Workspace (10 min.)	Lesson: Importing Sounds into MATLAB (20 min.)	Activity: Creating a Melody using Addition and Concatenation (45+ minutes)	Activity: Wrap Up (30 min.)
Discussion: What is Programming? (10 min.)	Activity: Playing by Numbers (15+ min.)	Lesson: Editing Sounds in MATLAB (30 min.)	Activity – Play with the MusicMixer App (15 mins)	
Activity – Acting Out Programming (20 mins)	Lesson: Using Functions (20+ min.) (optional)	Activity: Customizing Your Theremin (30+ min.)	Group Activity – Perform as a Band (30 mins)	
Activity: Using MATLAB to Visualize Sounds (20+ min.)	Activity: Sound Has Properties (15 min.)	Activity: Practicing While Loops (optional) (25 min.)	Activity – Creating a Music File of Your Own (30 minutes)	
Activity – Fun with MATLAB (15 mins)	Activity: Creating a Sound Wave and Playing it (20 min.)		Activity – Making a Circuit Board (60 minutes)	
Activity: Using MATLAB as a Calculator (15+ min.)	Lesson: Creating a Function (20+ min.)			
Lesson: Creating Numeric Variables and Variable Assignments (20 min.)	Activity: Changing Parameters, Changing the Sound (10 min.)			
Activity: Units per… (20 min.)	Activity: Creating a Function to Add Two Waves (15 min.)			

Activity: Customizing Your MATLAB (15 min.)	Activity: Playing Tones with the RedBoard (40 min.)			
Lesson: Creating Character Arrays (Strings) (10 min.)	Activity: Playing Chords Together (15min.)			
Lesson: Indexing into Character Arrays (10 min.)	Group Activity: Composing a Song (30+ minutes)			
Activity: Decoding a Secret Message (15 min.)				
Activity : Sending a Secret Message and Decoding (15 minutes)				
Lesson: Creating Arrays of Numbers (20 min.)				
Lesson: Connecting MATLAB to the Arduino Board (20+ min.)				
Total Time: ~4hrs	Total Time: ~4hrs	Total Time: ~4hrs	Total Time: ~4hrs	Total Time: ~4hrs

Course Materials Updated - July 2016