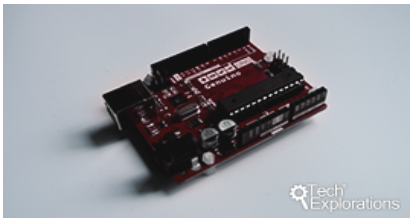

Tech Explorations
Arduino Step by Step

List of parts

Find a current list of parts, with links to Amazon, at https://www.txplore.com/p/asbsgsr-parts

Parts needed for all lectures

- 2 x Arduino Uno (some demos require 2 Arduinos)
- Assorted male-male jumper wires
- Assorted through-hole resistors
- Several LEDs

Software needed for all lectures

- Arduino IDE

Tools needed for all lectures

- A digital multimeter
- A battery pack or bench power supply
- Antistatic tweezers
- Power supply capable of supplying 5V and 12V, at least 1A

#	Section	Lecture	Components
1	**Introduction to this course**	Introduction	No parts needed
		Study guide	
		List of parts	
		Should you buy all the parts featuring in this course?	
		How to ask a question	
		How to report an error	
		Is this course right for you?	
2	**The BME280 environment sensor**	Introduction to the BME280	- BME280 environment sensor
		BME280 SPI wiring	
		BME280 I2C wiring	
		BME280 Sketch walkthrough and demo	
3	**The MPU6050 motion sensor**	Introduction to the MPU6050 motion sensor	- MPU6050 motion sensor
		A look at the MPU6050 datasheet	
		MPU6050 wiring	
		MPU6050 Arduino sketch	
		MPU6050 Processing demonstration	
		MPU6050 bonus lecture	
4	**Compass and magnetometer**	Introduction to the HMC5883 compass magnetometer	- HMC5883 compass
		HMC5883 wiring	
		HMC5883 sketch	
		HMC5883 demonstration	
5	**The flex sensor and membrane potentiometer**	Introduction to the flex sensor	- Flex sensor, 2.2" (5.588cm) long - Spectrasymbol membrane potentiometer (SoftPot)

		Flex sensor wiring	
		Flex sensor sketch	
		Introduction to the membrane potentiometer	
		Membrane potentiometer demonstration	
6	**The rotary encoder**	Introduction to the rotary encoder	- Rotary encoder
		Rotary encoder wiring and quadrature encoding	
		Rotary encoder sketch	
7	**Keypads**	Introduction to the keypad	- 4x4 flexible keypad - Phone-style keypad - 3 x 4.7 kΩ resistors - 4 x 1 kΩ resistors - 2 x 0.1 µF capacitor - 1 x 1 µF capacitor - 1 x MM74C922 decoder IC
		Working out the keypad pins	
		Keypad wiring	
		The phone keypad	
		Keypad 1-wire connection, Introduction	
		Keypad 1-wire connection, wiring	
		Keypad 1-wire connection, sketch	
		Keypad with the 74922 decoder IC, Introduction	
		Keypad with the 74922 decoder IC, wiring	
		Keypad with the 74922 decoder IC, sketch and demo	
		Bitwise operators	
8	**Graphics screen: Using a 1.8" TFT screen shield with joystick and SD card**	Introduction	- Adafruit 1.8" TFT Color shield with micro SD and joystick - Micro SD card
		Setup, graphics primitives and documentation	
		Displaying images from the SD card	
		Using the joystick and integrated button	
		How to create your own user interface: make the background image	
		How to create your own user interface: an example sketch	
9	**Graphics screen: Using a 2.2" TFT with SD Card**	Introduction	- Adafruit 240x320 2.2" TFT screen with the ILI9340C controller
		Wiring	
		Simple demonstrations	
		Displaying data	
		The library and resources	
10	**2.8 inch TFT display with touch interface and SD card module**	Introduction	- 2.8" TFT screen - Mcro-SD card
		Setup the IDE	
		Graphics functions and documentation	
		Test the touch interface	
		Test the SD card module	
		Create a custom user interface image	
		Create a custom user interface sketch	
11	**Graphics screen: using the 128x64 OLED SPI SH1106 display**	Introduction	- 128x64 OLED SPI display with the SH1106 controller
		Wiring	
		Libraries and support	
		Finding the right constructor for your screen	
		Demo sketch	

12	**8x8 LED matrix display**	Introduction	- 4 x 8x8 LED matrix displays using the MAX7219 controller
		Single display wiring	
		Single display sketch	
		Single display drawing	
		Custom graphics	
		Animation	
		Four 8x8 LED matrix display introduction	
		Four 8x8 LED matrix display graphics primitives	
13	**Seven Segment Displays**	Introduction	- Single seven segment display, common cathode - Dual seven segment display, common cathode - Seven segment clock display, common cathode - 0.56" 4-digit Seven segment clock display with I2C backpack - 74HC595 shift register IC - 8 x 330 Ω resistors
		Single display pin role discovery	
		Single display wiring	
		Single display sketch	
		Single display, working out the digit byte array	
		Single display with a single resistor	
		The sevseg library	
		Dual seven segment display, pin discovery	
		Dual seven segment display, wiring	
		Dual seven segment display, sketch	
		Single seven segment display with shift register, Introduction	
		Single seven segment display with shift register, wiring	
		Single seven segment display with shift register, sketch	
		Seven segment clock display - Introduction	
		Seven segment clock display - pin discovery	
		Seven segment clock display - wiring	
		Seven segment clock display - sketch	
		Seven segment clock display - Demo and wiring correction	
		Seven segment clock display with I2C backpack - Introduction and wiring	
		Seven segment clock display with I2C backpack - sketch	
		Seven segment clock display with I2C backpack - demo and wiring correction	
14	**LED strips**	White 12V LED strip with the TIP122 transistor, Introduction	- White 12V LED strip - RGB LED strip - 3 x TIP122 Darlington transistors - 12V power supply - 3 x 1 kΩ resistor
		White 12V LED strip with the TIP122 transistor, TIP122 datasheet	
		White 12V LED strip with the TIP122 transistor, circuit	
		White 12V LED strip with the TIP122 transistor, wiring test	
		White 12V LED strip with the TIP122 transistor, blinking	
		White 12V LED strip with the TIP122 transistor, fading	
		RGB LED strip with the TIP122, introduction	
		RGB LED strip with the TIP122, testing	
		RGB LED strip with the TIP122, circuit and wiring	
		RGB LED strip with the TIP122, sketch	
15	**Neopixel LED modules**	Adafruit Neopixel 5x8 shield, Introduction	- Adafruit Neopixel 5x8 shield - Adafruit Neopixel strip with 8 RGB LEDs - Adafruit Neopixel LED strip with 30 LEDs - 500 Ω resistor - 1000 µF capacitor - 5V power supply
		Adafruit Neopixel 5x8 shield, Quick setup and demo	
		Adafruit Neopixel 5x8 shield, Sketch, control single pixels	
		Adafruit Neopixel 5x8 shield, Sketch, draw graphic primitives	
		Adafruit Neopixel strip 8 LED, Introduction	
		Adafruit Neopixel strip 8 LED, Sketch introduction	
		Adafruit Neopixel strip 8 LED, Circuit and assembly	
		Adafruit Neopixel strip 8 LED, Sketch walkthrough	
		Adafruit Neopixel RGBW 30 LED strip, introduction	
		Adafruit Neopixel RGBW 30 LED strip, Wiring	
		Adafruit Neopixel RGBW 30 LED strip, Programming and demo	
		Adafruit Neopixel RGBW 30 LED strip, Sketch walkthrough	

16	**DC Motors**	Introduction to motors	- 2 x 5V DC motors - L298N motor controller - L8871 motor controller - Adafruit Motor Shield v2 - 5V power supply
		DC motors principles of operation	
		Motor control with the L298N, wiring	
		Motor control with the L298N, sketch and demo	
		Motor control with the L8871, introduction	
		Motor control with the L8871, Wiring	
		Motor control with the L8871, sketch and demo	
		Motor control with the Adafruit Motor Shield v2, introduction	
		Motor control with the Adafruit Motor Shield v2, Wiring	
		Motor control with the Adafruit Motor Shield v2, Sketch and demo	
17	**Servo motors**	Introduction to servo motors	- 2x Basic mini servo motor - Continuous rotation servo motor - Adafruit Servo shield
		Direct control of a servo motor, wiring	
		Direct control of a servo motor, sketch and demo with one motor	
		Direct control of a servo motor, sketch and demo with two motors	
		Define servo motor moves in an array	
		Continuous rotation servo motor	
		The Adafruit Servo Shield, introduction	
		The Adafruit Servo Shield, wiring	
		The Adafruit Servo Shield, Sketch	
		The Adafruit Servo Shield, Control an LED	
18	**Stepper motors**	Introduction to stepper motors	- NEMA17 stepper motor - L293 motor controller - EasyDriver motor controller - Unipolar stepper motor - Adafruit Motor Shield - ULN2003 motor controller - 12V power supply - 5V power supply
		Dissecting a bipolar stepper motors	
		How to determine the coil wires of a bipolar stepper motor	
		NEMA17 with the L293 controller and Stepper library, introduction and wiring	
		NEMA17 with the L293 controller and Stepper library, sketch and demo	
		NEMA17 with the Easy Driver controller, introduction	
		NEMA17 with the Easy Driver controller, wiring	
		NEMA17 with the Easy Driver controller, sketch	
		NEMA17 with the Easy Driver controller and AccelStepper, introduction and sketch	
		NEMA17 with the Easy Driver controller and AccelStepper, demo	
		NEMA17 with the Adafruit Motor Shield v2 and AccelStepper, introduction & sketch	
		NEMA17 with the Adafruit Motor Shield v2 and AccelStepper, Demo	
		Unipolar stepper motor with Adafruit Motor Shield, introduction	
		Unipolar stepper motor with Adafruit Motor Shield, determining coil wires	
		Unipolar stepper motor with Adafruit Motor Shield, demo	
		Unipolar stepper motor with the ULN2003 driver, introduction	
		Unipolar stepper motor with the ULN2003 driver, wiring	
		Unipolar stepper motor with the ULN2003 driver, sketch & demo	
19	**Networking with the Ethernet Shield**	Introduction to Ethernet networking	- Ethernet shield with the Wiznet 5100 controller - 10 kΩ photo resistor - 2 x 10 kΩ resistor - DHT22 sensor - LED - 330 Ω resistor
		The Ethernet shield	
		Simple chat server, introduction and wiring	
		Simple chat server, demonstration	
		Simple chat server, sketch	
		Simple chat server with LCD shield, wiring and demo	
		Simple chat server with LCD shield, sketch	
		Simple reporting web server, introduction and wiring	
		Simple reporting web server, sketch walkthrough part 1	
		Simple reporting web server, HTTP request formating	
		Simple reporting web server, sketch walkthrough part 2	
		Simple reporting web server outputting CSV formatted data	

		Simple controlling web server with one LED, wiring and demo	
		Simple controlling web server with one LED, sketch	
		Simple controlling web server with two LEDs	
20	**Networking with the ATWINC1500 Wifi module**	Introduction to the ATWINC1500 Wifi module	- Adafruit ATWINC1500 Wifi module - An Amazon AWS account - DHT22 sensor - 10 kΩ photo resistor - 10 kΩ resistor - 2 x LED - 2 x 330 Ω resistors
		Wiring the Adafruit ATWINC1500 breakout	
		Adafruit ATWINC1500 Wifi breakout, simple demo	
		Adafruit ATWINC1500 Wifi breakout, sketch walkthrough	
		Adafruit ATWINC1500 Wifi breakout, firmware version check	
		ATWINC1500 Wifi breakout firmware upgrade	
		ATWINC1500 Wifi breakout SSL certificate update	
		ATWINC1500 Simple reporting server, wiring	
		ATWINC1500 Simple reporting server, sketch	
		ATWINC1500 Simple reporting server, demonstration	
		ATWINC1500 controlling LEDs with a CSV file on Amazon S3, introduction	
		ATWINC1500 controlling LEDs with a CSV file on Amazon S3, Setup the S2 service	
		ATWINC1500 controlling LEDs with a CSV file on Amazon S3, Demonstration	
		ATWINC1500 controlling LEDs with a CSV file on Amazon S3, sketch	
		ATWINC1500 controlling LEDs with a simple web server, introduction & demo	
		ATWINC1500 controlling LEDs with a simple web server, sketch	
21	**Shift registers**	Introduction to Shift Registers	- 2 x 74HC595 shift register ICs - 16 x 220 Ω resistors - 16 x LEDs - 470 µF capacitor
		Driving 8 LEDs with one 595 Shift Register, introduction and IC pin roles	
		Driving 8 LEDs with one 595 Shift Register, Assembly	
		Driving 8 LEDs with one 595 Shift Register, Sketch	
		Driving 16 LEDs with two 595 Shift Registers, introduction	
		Driving 16 LEDs with two 595 Shift Registers, wiring	
		Driving 16 LEDs with two 595 Shift Registers, sketch	
22	**Simple Bluetooth connectivity with the HC-06**	Introduction to the HC-06	- HC-06 Bluetooth module - 10 kΩ photo resistor - 10 kΩ resistor - LED - 330 Ω resistor
		HC-06 Wiring	
		HC-06 Pairing	
		HC-06 Reading sensor data	
		HC-06 with SoftwareSerial	
23	**Bluetooth Low Energy (BLE) with the nRF8001**	Introduction to BLE	- Adafruit BLE breakout with the nRF8001 module - A smartphone - RGB LED - 5 x 330 Ω resistors - 2 x LEDs - 10 kΩ photo resistor
		A few things about the BLE standard	
		nRF8001 setup	
		nRF8001 callBack Echo demo	
		nRF8001 simple duplex communications demo	
24	**Adafruit Bluefruit LE UART Friend**	Introduction	- Adafruit Bluefruit LE UART Friend - A smartphone - RGB LED - 5 x 330 Ω resistors - 2 x LEDs - 10 kΩ photo resistor - 10 kΩ resistor
		Pinouts	
		Wiring and Demo	
		Firmware update	
		AT Commands	
		Serial data link demo	
		Controlling data link demo	

		HID Keyboard sketch	
		HID Keyboard demo	
		Controller demo	
25	**Wireless connectivity with the nRF24**	Introduction to the nRF24	- 2 x nRF24L01+ modules - 2 Arduino Unos - 2 x 470 µF capacitors - 2 x LED - 2 x 330 Ω resistors - 20 kΩ resistor - 10 kΩ photo resistor - 10 kΩ resistor - Breadboard friendly momentary button
		Module pinout	
		Simple test wiring	
		Simple test sketch	
		Simple test demo	
		Comprehensive demo	
		Comprehensive demo sketch	
26	**Simple radio communications at 433Mhz**	Introduction	- 1 x 433Mhz receiver XY-MK-5V - 1 x 433Mhz transmitter XY-FST - 2 x LED - 2 x 330 Ω resistor
		Receiver and transmitter pins and wiring	
		Receiver and transmitter sketches	
		Demo	
28	**External Storage**	Reading and writing to an SD card, Part 1 of 3	- SD card module with SPI for Arduino - A blank SD card formatted as FAT16 - External EEPROM module, 256 kB with the 24C256 - 2 x 10 kΩ photo resistor - 10 kΩ resistor
		Reading and writing to an SD card, Part 2 of 3	
		Reading and writing to an SD card, Part 3 of 3	
		EEPROM (internal and external) Part 1: Basic use	
		EEPROM (internal and external) Part 2: the EEPROMex library	
		EEPROM (internal and external) Part 3: Using an external EEPROM	
29	**Interrupts**	Hardware interrupts Part 1: Introduction	- Arduino Uno - LED - 300 Ω resistor - 10 kΩ resistor - Breadboard-friendly momentary button
		Hardware interrupts Part 2: Using volatile variables	
		Hardware interrupts Part 3: Timers	
		Hardware interrupts Part 4: High-definition Pulse Width Modulation	
30	**Memory and power management**	Memory management Part 1: Introduction and Flash	- Arduino Uno
		Memory Management Part 2: Static RAM	
		Power management with sleep mode and prescaling	
31	**Internal pull-up resistors**	Using the build-in pull-up resistors	- Arduino Uno - LED - 330 Ω resistor - 10 kΩ resistor
32	**Hardware debouncing**	Hardware switch/button debouncing Part 1: Background	- 1 x 74HC14 Schmiddt trigger IC - 100 nF capacitor - 20 µF capacitor (optional) - 100 Ω resistor
		Hardware switch/button debouncing Part 2: Demo	
33	**Port expander**	Control more devices with a port expander, Part 1: Background and setup	- 1 x MCP23017 Port expander - 4 x 10 kΩ resistors - 2 x LED - 2 x 330 Ω resistors
		Control more devices with a port expander, Part 2: more examples	
34	**Real time clock**	Real time clock, Part 1 of 2	- RTC module TinyRTC v1.1

		Real time clock, Part 2 of 2	- SD card module - Photoresistor - Thermistor
35	**Controlling large loads with relays and friends**	Using the TIP22 transistor to control an LED strip	- TIP122 Darlington transistor - 12V power supply - 12V LED strip - 5V relay - 2N2222 transistor - 1 kΩ resistor
		Relays Part 1: Introduction	
		Relays Part 2: How NOT to control a relay	
		Relays Part 3: Connect a 12V relay component calculations	
		Relays Part 4: Connect a 12V relay connections	
		Relays Part 5: Relay shields	
36	**Location sensing**	Introduction to GPS	- Adafruit Ultimate GPS breakout
		Wiring the Adafruit module for direct communication with computer	
		Getting and using raw text data from the module	
		Using the Adafruit GPS library	
		Using the TinyGPS+ library	
37	**Make a bare-bones Arduino**	Intro and power circuit	- Atmega 328P - 16MHz crystal oscillator - 2 x 22 pF capacitors - 2 x 10 uF capacitors - 7805 Voltage regulator - 2 x LEDs - 2 x 330Ω resistors - Breadboard-friendly momentary button
		Atmega, reset and clock	
		Power LED and testing	
		Create your own printed circuit boards (PCB), Part 1	
		Create your own printed circuit boards (PCB), Part 2	
38	**How to use Processing (language) with the Arduino**	Using Processing (the language) with the Arduino, Part 1	- DHT22 sensor - 2 x 10 kΩ resistors - 220 Ω resistor - 10 kΩ potentiometer - LED
		Using Processing (the language) with the Arduino, Part 2	
39	**Make your own simple library**	Create your own Library, Part 1	No parts needed
		Create your own Library, Part 2	
40	**Simple security with a fingerprint scanner**	Introduction to the fingerprint scanner	- Fingerprint sensor - Electromagnetic lock - TIP122 - 12V power supply
		Wiring, registering and recognizing fingerprints	
		Sketch and demonstration with an electric lock	
41	**Small projests**	Arduino-Raspberry Pi wireless communication with the RF24	- Any version of the Raspberry Pi - Arduino Uno - 2 x nRF24L01+ module
		A home notification board with a large display	- 16x32 LED matrix display - Piezo buzzer - RTC breakout - DHT22 sensor

		Using a magnetometer to detect motion	- 3-axis HMC5883L magnetometer