



Tech Explorations Arduino Step by Step Getting Serious

List of 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
- Breadboard friendly momentary buttons

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	
	Introduction to this			
1	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		- BME280 environment sensor	
_	environment sensor	Introduction to the BME280		
		BME280 SPI wiring		
		BME280 I2C wiring		
		BME280 Sketch walkthrough and demo		
,	The MPU6050 motion		- MPU6050 motion sensor	
,	sensor	Introduction to the MPU6050 motion sensor		
		A look at the MPU6050 datasheet		
		MPU6050 wiring		
		MPU6050 Arduino sketch		
		MPU6050 Processing demonstration		
		MPU6050 bonus lecture		
,	Compass and		- HMC5883 compass	
4	magnetometer	Introduction to the HMC5883 compass magnetometer		
		HMC5883 wiring		
		HMC5883 sketch		
		HMC5883 demonstration		
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	The flex sensor and		
	membrane		- Flex sensor, 2.2" (5.588cm) long - Spectrasymbol membrane potentiometer (SoftPot)
_	potentiometer	Introduction to the flex sensor	- Spectrasymbol membrane potentiometer (SoftPot)
	potentiometer	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
		Working out the keypad pins	- Phone-style keypad
		Keypad wiring	- 3 x 4.7 kΩ resistors
		The phone keypad	– 4 x 1 kΩ resistors – 2 x 0.1 μF capacitor
		Keypad 1-wire connection, Introduction	- 2 x 0.1 μF capacitor - 1 x 1 μF capacitor
		Keypad 1-wire connection, wiring	- 1 x MM74C922 decoder IC
		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	
	Graphics screen: Using a		- Adafruit 1.8" TFT Color shield with micro SD and joystick
8	1.8" TFT screen shield		- Micro SD card
	with joystick and SD		
	card	Introduction	
		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	
		now to create your own user interface, an example sketch	
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9	Graphics screen: Using a		- Adafruit 240x320 2.2" TFT screen with the ILI9340C
	2.2" TFT with SD Card	Introduction	controller
		Wiring	
		Simple demonstrations	
		Displaying data	
		The library and resources	
	2.8 inch TFT display with		2.9" TET ceroon
10	touch interface and SD		- 2.8" TFT screen - Mcro-SD card
	card module	Introduction	
		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	

	Graphics screen: using		- 128x64 OLED SPI display with the SH1106 controller
11	the 128x64 OLED SPI		.2004 OLLO STE display with the SITT TOO CONDUNCT
	SH1106 display	Introduction	
		Wiring	
		Libraries and support	
		Finding the right constructor for your screen	
		Demo sketch	
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12	8x8 LED matrix display	Introduction	
	-	Single display wiring	- 4 x 8x8 LED matrix displays using the MAX7219 controller
		Single display sketch	
		Single display drawing	
		Custom graphics	
		Animation	
		Four 8x8 LED matrix display introduction	
		Four 8x8 LED matrix display graphics primitives	İ
		Introduction	
13	Seven Segment Displays	9	- Single seven segment display, common cathode
		Single display pin role discovery	- Dual seven segment display, common cathode - Seven segment clock display, common cathode
		Single display wiring	- 0.56" 4-digit Seven segment clock display with I2C
		Single display sketch	backpack
		Single display, working out the digit byte array	- 74HC595 shift register IC
		Single display with a single resistor	- 8 x 330 Ω resistors
		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	
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14	LED strips	White 12V LED strip with the TIP122 transistor, TIP122 datasheet	- White 12V LED strip - RGB LED strip
		White 12V LED strip with the TIP122 transistor, Fir 122 datasheet	- 3 x TIP122 Darlington transistors
		: }	- 12V power supply
		White 12V LED strip with the TIP122 transistor, wiring test	- 3 x 1 kΩ resistor
		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 5x8 shield, Quick setup and demo	- Adafruit Neopixel strip with 8 RGB LEDs

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NEMA17 with the Adafruit Motor Shield v2 and AccelStepper, introduction & sketch NEMA17 with the Adafruit Motor Shield v2 and AccelStepper, Demo			
introduction & sketch NEMA17 with the Adafruit Motor Shield v2 and AccelStepper, Demo			
Unipolar stepper motor with Adafruit Motor Shield, introduction		NEMA17 with the Adafruit Motor Shield v2 and AccelStepper, Den	10
		Unipolar stepper motor with Adafruit Motor Shield, introduction	

Unipolar stepper motor with Adafruit Motor Shield, determining coil

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

wires

Networking with the		- Adafruit ATWINC1500 Wifi module
	Simple controlling web server with two LEDs	
	Simple controlling web server with one LED, sketch	
	Simple controlling web server with one LED, wiring and demo	
	Simple reporting web server outputting CSV formatted data	
	Simple reporting web server, sketch walkthrough part 2	
	Simple reporting web server, HTTP request formating	
	Simple reporting web server, sketch walkthrough part 1	
	Simple reporting web server, introduction and wiring	
	Simple chat server with LCD shield, sketch	
	Simple chat server with LCD shield, wiring and demo	
	Simple chat server, sketch	
	Simple chat server, demonstration	- 330 Ω resistor
	Simple chat server, introduction and wiring	- LED
	The Ethernet shield	- 2 x 10 km resistor
Ethernet Shield	Introduction to Ethernet networking	- 10 kΩ photo resistor
Networking with the		- Ethernet shield with the Wiznet 5100 controller

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	Networking with the	
20	ATWINC1500 Wifi	
	module	Introduction to the ATWINC1500 Wifi module
		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 53, 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

- An Amazon AWS account
- DHT22 sensor
- 10 $k\Omega$ photo resistor
- 10 kΩ resistor
- 2 x LED
- 2 x 330 Ω resistors

21 Shift registers		Introduction to Shift Registers	
		Driving 8 LEDs with one 595 Shift Register, Introduction and IC pin roles	- ·
	<u> </u>	Driving 8 LEDs with one 595 Shift Register, Assembly	- 4
		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	

- 2 x 74HC595 shift register ICs
- 16 x 220 Ω resistors
- 16 x LEDs
- 470 μF capacitor

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ĺ		Simple Bluetooth		
22 co		connectivity with the HC-		
į		06	Introduction to the HC-06	
į			HC-06 Wiring	
2			HC-06 Pairing	
2			HC-06 Reading sensor data	

- HC-06 Bluetooth module
- 10 $k\Omega$ photo resistor
- 10 kΩ resistor
- LED
 - 330 Ω resistor

uetooth Low Energy LE) with the nRF8001	HC-06 with SoftwareSerial Introduction to BLE A few things about the BLE standard	- Adafruit BLE breakout with the nRF8001 module - A smartphone
	·	±
	·	±
LE) with the nRF8001	·	- A smartphone
	A few things about the BLF standard	
	: 	- RGB LED - 5 x 330 Ω resistors
	nRF8001 setup	- 2 x LEDs
	nRF8001 callBack Echo demo	- 10 kΩ photo resistor
	nRF8001 simple duplex communications demo	- 10 kΩ resistor
		·
lafruit Bluefruit LE		- Adafruit Bluefruit LE UART Friend
\RT Friend	Introduction	- A smartphone
	Pinouts	- RGB LED - 5 x 330 Ω resistors
	Wiring and Demo	- 2 x LEDs
	Firmware update	- 10 kΩ photo resistor
	AT Commands	- 10 kΩ resistor
	Serial data link demo	
	Controlling data link demo	
	HID Keyboard sketch	
	HID Keyboard demo	
••••••	Controller demo	
	*	
ireless connectivity		- 2 x nRF24L01+ modules
th the nRF24	Introduction to the nRF24	- 2 Arduino Unos
	Module pinout	- 2 x 470 μF capacitors - 2 x LED
	Simple test wiring	- 2 x 330 Ω resistors
	Simple test sketch	- 20 kΩ resistor
	Simple test demo	- 10 kΩ photo resistor
	Comprehensive demo	- 10 kΩ resistor - Breadboard friendly momentary button
	Comprehensive demo sketch	- 2x16 character LCD screen with I2C backpack
mnle radio		- 1 x 433Mhz receiver XY-MK-5V
•		- 1 x 433Mhz transmitter XY-FST
	Introduction	- 2 x LED
		- 2 x 330 Ω resistor
	<u> </u>	
tornal Storage	Reading and writing to an SD card, Part 1 of 3	
ternar storage	i	- 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
	<u>.</u>	- Thermistor
	ELF NOW (Internal and external) Fare 3. Osing an external ELF NOW	
torrunts	:Hardware interrupts Part 1: Introduction	Arduina Una
iei i upio		- Arduino Uno - LED
	: \$	- 300 Ω resistor
	manaware interruptor art 3. Hillers	- 10 kΩ resistor
	Hardware interrupts Part 4: High-definition Pulse Width Modulation	- Breadboard-friendly momentary button
	¥	
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emory and power	Memory management Part 1: Introduction and Flash	- Arduino Uno
it i		AT Commands Serial data link demo Controlling data link demo HID Keyboard sketch HID Keyboard demo Controller demo Controller demo Introduction to the nRF24 Module pinout Simple test wiring Simple test sketch Simple test sketch Comprehensive demo Comprehensive demo Comprehensive demo Comprehensive demo sketch Introduction Receiver and transmitter pins and wiring Receiver and transmitter sketches Demo Reading and writing to an SD card, Part 1 of 3 Reading and writing to an SD card, Part 2 of 3 Reading and writing to an SD card, Part 1 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 Hardware interrupts Part 1: Introduction Hardware interrupts Part 2: Using volatile variables Hardware interrupts Part 3: Timers

		List Of parts	
		Power management with sleep mode and prescaling	
	```		
	Internal pull-up resistors	Using the build-in pull-up resistors	- Arduino Uno - LED - 330 Ω resistor - 10 kΩ resistor - Breadboard-friendly momentary button
22	Uardurare debounding	Hardware switch/button debouncing Part 1: Background	
32	Hardware debouncing	Hardware switch/button debouncing Part 2: Demo	- 1 x 74HC14 Schmiddt trigger IC - 100 nF capacitor - 20 μF capacitor (optional) - 100 Ω resistor - 2 x 10 kΩ resistor
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
		Control more devices with a port expander, Part 2: more examples	- 2 x LED - 2 x 330 Ω resistors - Breadboard-friendly momentary button
		Destruction dest. Dest 4 of 0	
34	Real time clock	Real time clock, Part 1 of 2  Real time clock, Part 2 of 2	- RTC module TinyRTC v1.1 - SD card module - Photoresistor - Thermistor - 2 x 10 kΩ resistors
35	Controlling large loads with relays and friends	Using the TIP22 transistor to control an LED strip 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	- TIP122 Darlington transistor - 12V power supply - 12V LED strip - 5V relay - 2N2222 transistor - 1 kΩ resistor
36	Location sensing	Introduction to GPS  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	- Adafruit Ultimate GPS breakout
37	Make a bare-bones Arduino	Intro and power circuit Atmega, reset and clock	- Atmega 328P - 16MHz crystal oscillator - 2 x 22 pF capacitors
		Power LED and testing  Create your own printed circuit boards (PCB), Part 1	- 2 x 10 uF capacitors - 7805 Voltage regulator
		Create your own printed circuit boards (PCB), Part 2	- 2 x LEDs - 2 x 330Ω resistors - Breadboard-friendly momentary button - Fritzing PCB design software (free)
	How to use Processing		
	TIOW TO USE PROCESSING		- DHT22 sensor
- 1	(language) with the Arduino	Using Processing (the language) with the Arduino, Part 1	- 2 x 10 kΩ resistors - 220 Ω resistor - 10 kΩ potentiometer

39	Make your own simple library	Create your own Library, Part 1 Create your own Library, Part 2	No parts needed
40	Simple security with a fingerprint scanner  Introduction to the fingerprint scanner  Wiring, registering and recognizing fingerprints  Sketch and demonstration with an electric lock		- Fingerprint sensor - Electromagnetic lock - TIP122 - 12V power supply
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 - Arduino Ethernet shield
		Using a magnetometer to detect motion	- 3-axis HMC5883L magnetometer