

EET K258 Lab #5

Mixed signal Breadboard

Name: _____

Last edit: 20 Feb 2019

Safety: This introductory lab poses no safety hazards. The power supply has a low output voltage and includes a current limiting feature. There are no storage elements such as capacitors or inductors. Nonetheless, later labs will present significant hazards to life and limb. With this in mind, we will strive to develop habits that will keep us safe in the future. Specifically:

- There will be a lab instructor observing your activities at all times.
- Remove all watches, rings, and exposed necklaces.
- Keep your lab work area clean.
- This lab is comprised on dozens of individual steps. To help you keep track of where you are, add a check mark as you complete each step.
- Observe all of the “**Stop**, do not proceed until your lab instructor inspects...” directions. This allows someone to double check your wiring and verify you are ready for the experiment.
- You can expect your instructor to ask you questions about the portion of the experiment you are going to perform. Most questions will be centered on applications of the fundamental concepts and equations. You may be asked to collaborate with your classmates before proceeding.

Equipment:

PC	Arduino nano microcontroler
Keysight E3631A DC Power Supply	Fluke 115 digital multimeter
2ea Breadboard	2ea 1 k Ω resistors
2ea 2.2 k Ω resistors	4ea 10 k Ω resistors
2ea 390 k Ω resistors	2ea 500 k Ω potentiometer
2ea LM741 op-amp	2ea PN2222A transistor
2ea 1 uF electrolytic capacitor	2ea 0.1 uF film capacitor

Objective:

- **Breadboard** a mixed signal circuit
- **Explore** operation of the Arduino PWM

Deliverables:

30 points: an exact functional copy of the breadboard

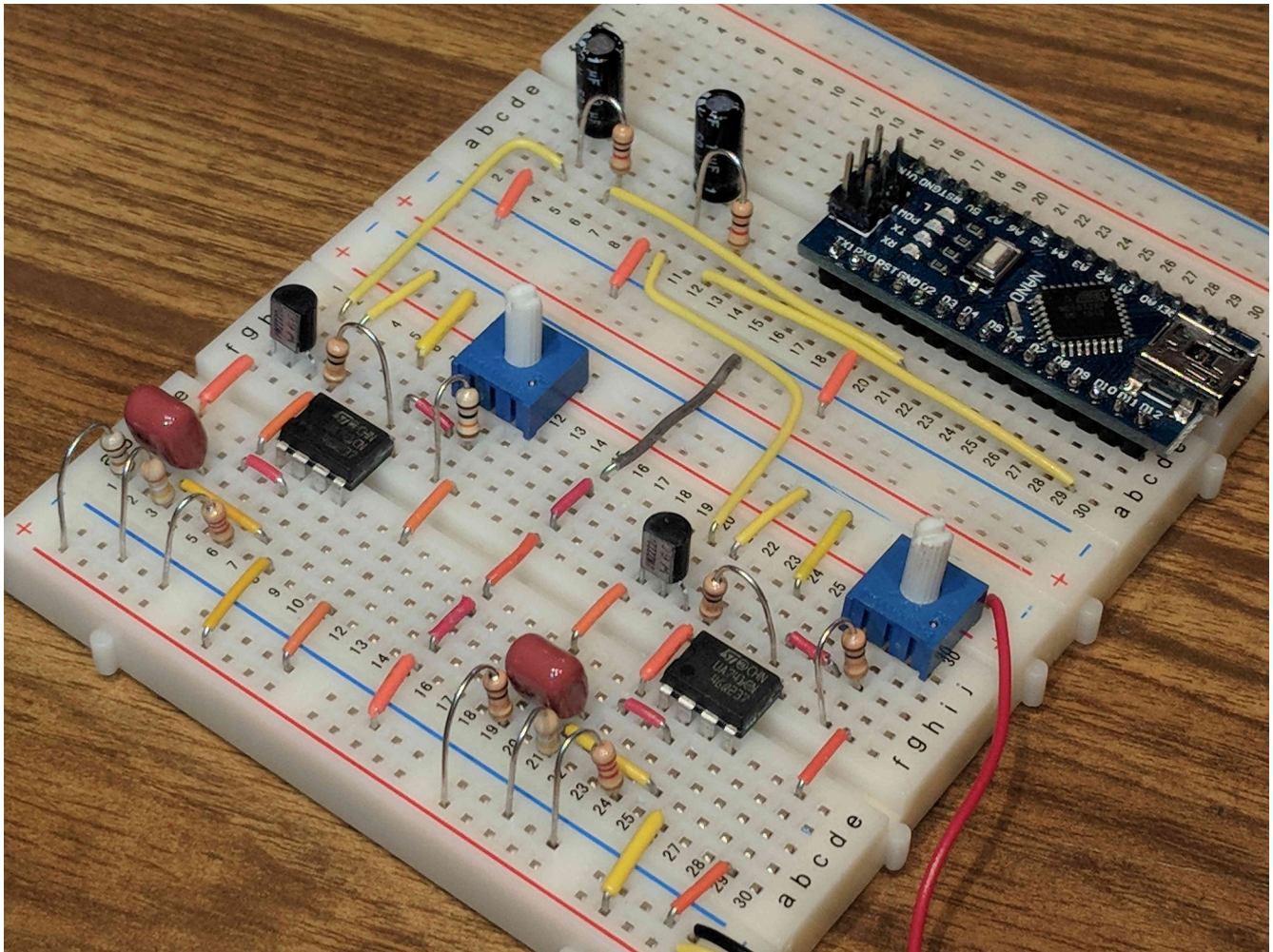
10 points: complete discussion questions attached to this document

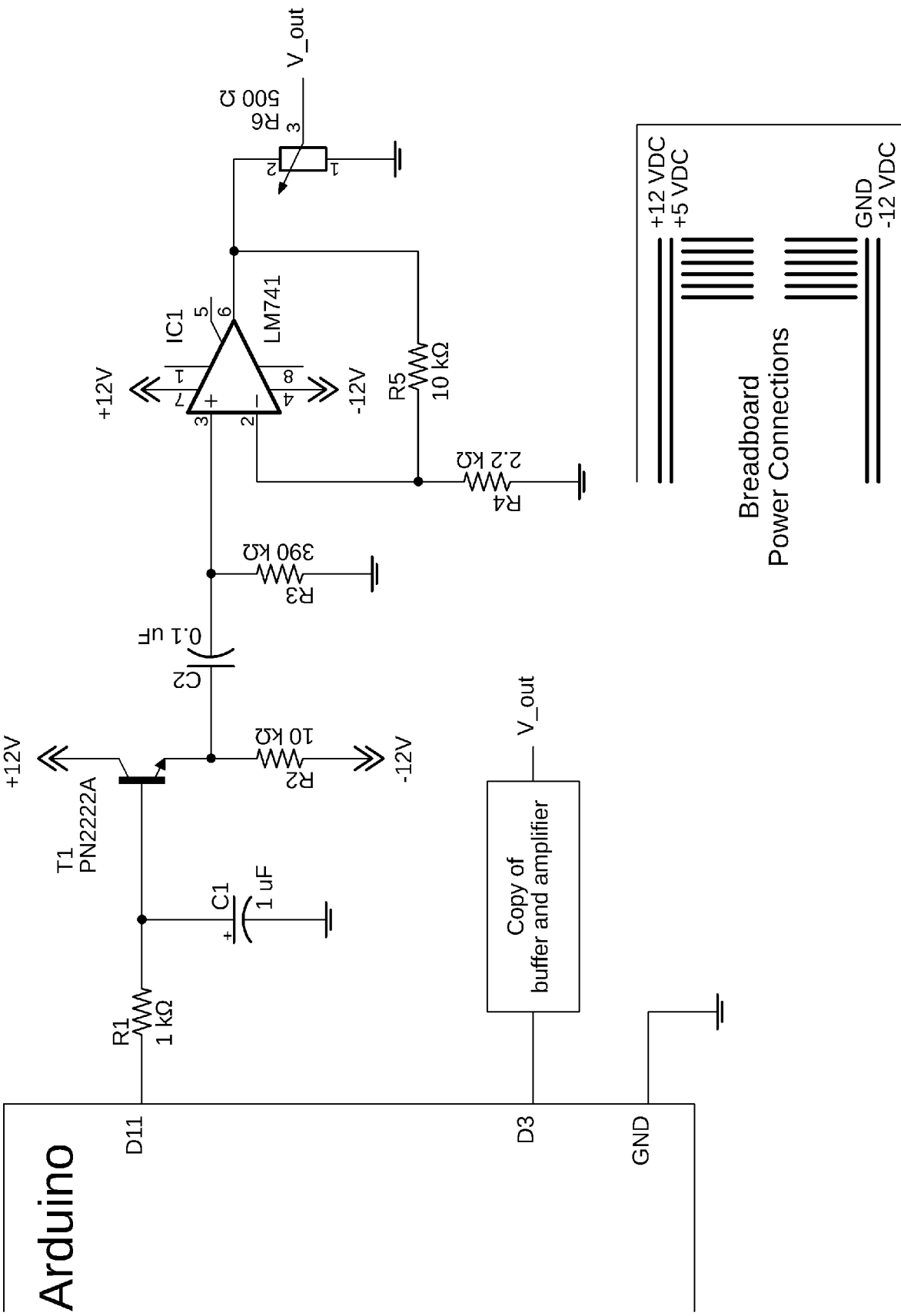
Chalk talk:

- Download the code, pictures, and schematic from Blackboard.
- Operation of the Arduino PWM
- Low pass filter
- Common collector (emitter follower) amplifier
- Non-inverting op-amp

Procedure:

- 1) **Copy** the physical circuit shown in this picture. For your reference, a schematic is found on the next page. Also, you can find full color photographs on Blackboard.





2) **Program** the Arduino using the lab 5 code from Blackboard.

3) **Answer** the following questions:

A) (1 pt) describe the output signal from the 741 op-amp:

Frequency =

Amplitude =

B) (2 pts) Describe the signal as measured at the output of the Arduino D11 pin:

Frequency =

Amplitude =

How is this signal transformed into a sinusoidal signal?

C) (1 pt) What is the time constant of the low pass filter formed by R1 and C1? How does this relate to the previous two questions?

D) (1 pt) What is the purpose of capacitor C2?

E) (1 pt) Research non-inverting op-amp. What is the gain of the 741 amplifier stage?

F) (1 pt) Research the term Direct Digital Synthesis (DDS). Explore the various code files associated with this project as provided by the instructor. One of those files contains a large look-up table. Describe the contents of the table?

G) (3 pts) Research C programming. What is contained in:

.h file

.cpp file

.ino file?