

Name Theodore Yiu Start Time 17:00 End Time 18:30

**ME430 - Mechatronics**

Examination I

Summer 2022

Problem	Score
1	/ 22
2	/ 18
3	/ 10
Computer Part	/ 50
Total	/100

For the written part of the exam, you may use only:

- One sheet of paper notes. Front and back 8.5" by 11", typed or handwritten (any font size is fine). The notes page must be made by you, not someone else.
- A pencil/pen.
- A calculator. Maple **may** be used as a calculator, but no other computer usage beyond playing music is allowed.

In addition to those materials, for the computer part of the exam, you may also use:

- Your computer.
- Any paper notes (such as notes on the videos), so long as those notes were written by you or provided as course materials.
- Any electronic notes or code residing on your local (C:) hard drive, so long as those notes/code were written by you or your lab partner.
- The course website and Moodle. These are the only approved websites allowed during the exam.

Anything not specifically allowed is prohibited. In particular, you may not use notes or code written by someone outside your lab group.

**References****Resistor sizes**

- E6 (20%): 10 15 22 33 47 68
- E12 (10%): 10 12 15 18 22 27 33 39 47 56 68 82
- E24 (5%): 10 11 12 13 15 16 18 20 22 24 27 30 33 36 39 43 47 51 56 62 68  
75 82 91

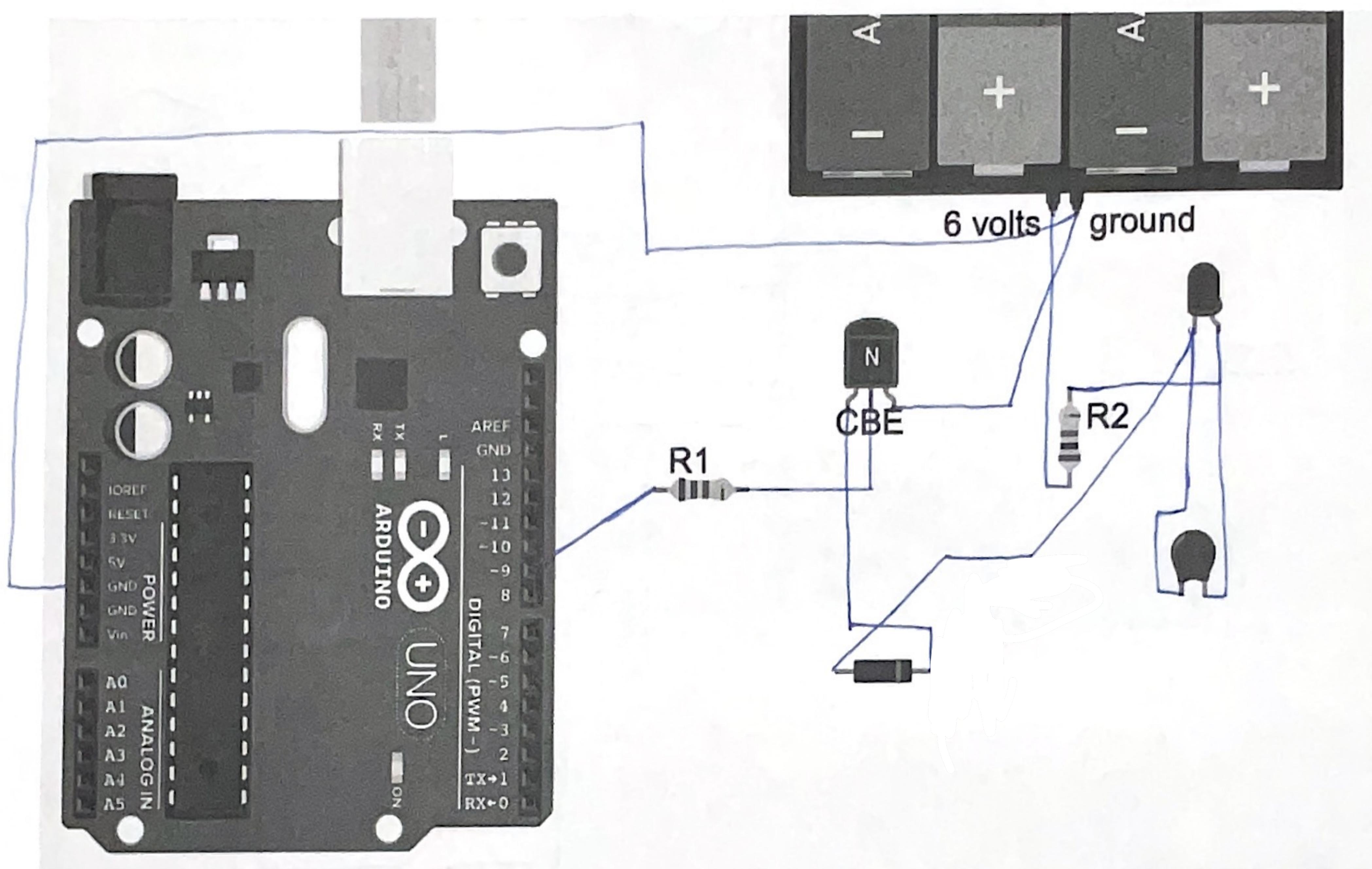
**Color bands**

Color	1 <sup>st</sup> band	2 <sup>nd</sup> band	3 <sup>rd</sup> band (multiplier)
Black	0	0	$\times 10^0$
Brown	1	1	$\times 10^1$
Red	2	2	$\times 10^2$
Orange	3	3	$\times 10^3$
Yellow	4	4	$\times 10^4$
Green	5	5	$\times 10^5$
Blue	6	6	$\times 10^6$
Violet	7	7	$\times 10^7$
Grey	8	8	$\times 10^8$
White	9	9	$\times 10^9$

Note: When you submit your PDF to Gradescope (via Moodle), this page and the title page **SHOULD** be included. Gradescope gets messed up if you omit pages. Likewise it gets messed up if you submit too many pages. This is page 2 that is submitted to Gradescope. Note, the Computer Part page(s) are NOT submitted to Gradescope, just this PDF in entirety.

**Problem 1 – BJT**

Connect the wires on the circuit below, so that pin 9 of the Arduino controls the LED using the NPN BJT shown. The LED has a forward voltage drop of 1.8 volts and a **maximum** current rating of 30 mA. In the image below R1, the resistor for the BJT, is 1k and R2, the resistor for the LED is 1k (which are both wrong). Wire the circuit below by drawing wires, then size what the resistors should be (using the boxes below for your answers). Add the snubber diodes and decoupling capacitors if needed.



R2 size, the LED resistor, to get the correct current for the LED (*i.e. HALF of the maximum current*)

Exact Resistor Value

200  $\Omega$

Real Resistor (E12 Series)

220  $\Omega$   
~~220  $\Omega$~~

What are the Color Bands for that resistor

Red Red Brown

R1 size, the BJT resistor, to get 1/10th the current through the BJT vs the LED.

Exact Resistor Value

1666.67  $\Omega$   
~~1666.67  $\Omega$~~

Real Resistor (E12 Series)

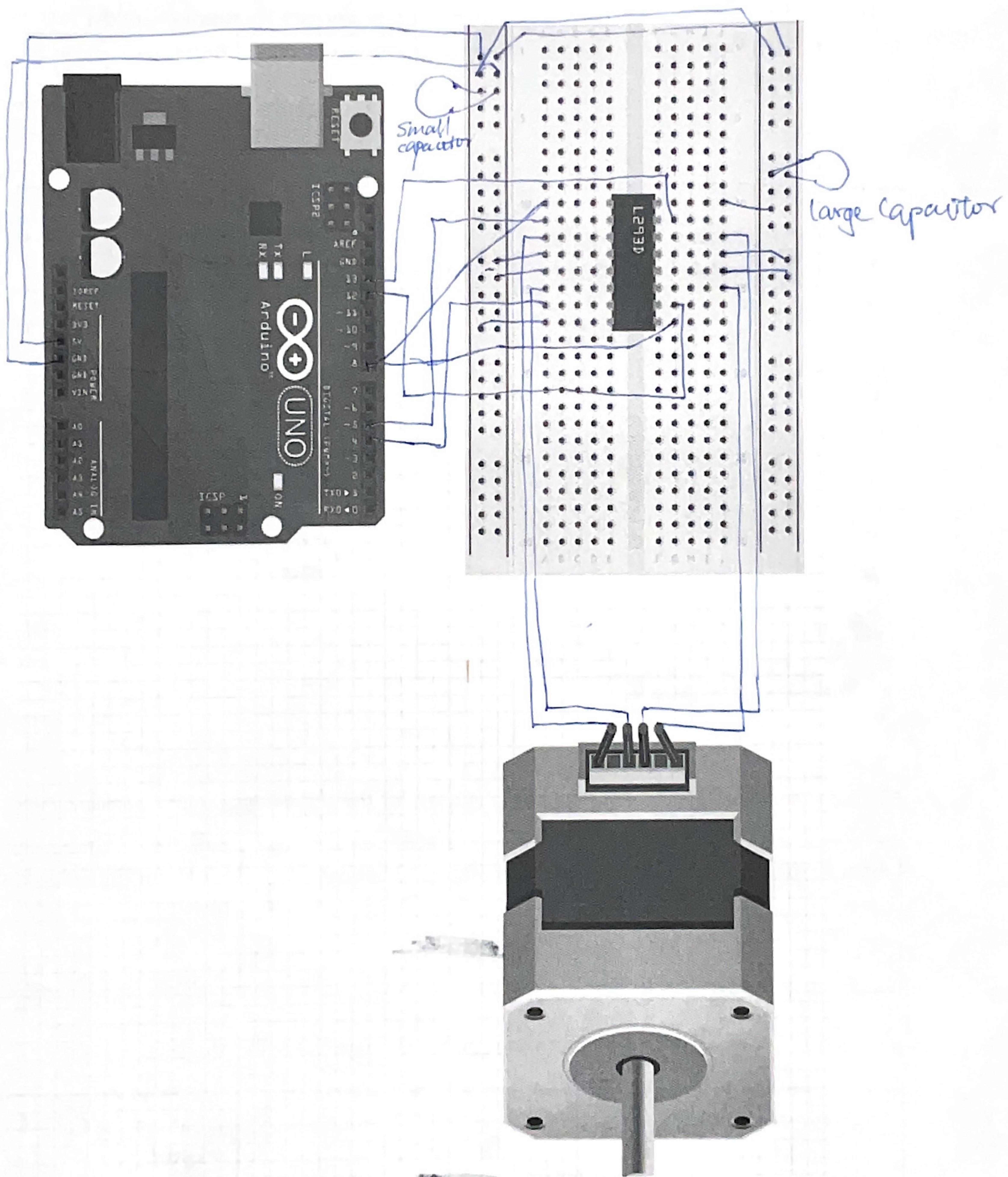
1800  $\Omega$   
~~1800  $\Omega$~~

What are the Color Bands for that resistor

Brown Grey Red

**Problem 2 – Stepper Motor Wiring**

Draw wires onto the circuit below to appropriately drive the stepper motor using the provided L293D chip with a Bipolar drive circuit. Use the Arduino Vin pin to power the motor and the Arduino 5v pin for other L293 power needs.



Use Arduino pins 4 and 5 to control one stepper motor pair and pins 12 and 13 for the other stepper motor pair. Use Arduino pin 8 for both L293D Enable lines. For the stepper motor wires, you can assume the left two wires are a pair and the right two wires are a pair. You do NOT need to add snubber diodes to this circuit. However, DO add a big and small decoupling capacitor to appropriate rails.

**Problem 3 – Servo Wiring**

Draw wires onto the circuit below to appropriately drive the servo motor. Assume the microcontroller is programmed such that pins 7 and 8 are INPUT\_PULLUP pins for the pushbuttons and pin 11 is set up to control the servo. You can assume the code moves the servo to position 1 when pushbutton 1 is pressed and position 2 when pushbutton 2 is pressed, but that doesn't really concern you. You are just doing the wiring (be careful to think about ground btw). Additionally you can add appropriate resistors and diodes as you feel necessary.

