Practical 2: Build a DC motor

What is it about?

Let's build a DC motor from scratch! You have **2 weeks** to: (1) build a first version, (2) iterate and optimise the design, (3) build a better version of your motor.

Aims

At the end of the practical, you should:

- know the key parts of a DC motor
- have gained an experimental intuition of the physics behind DC motors
- have a working and reasonably efficient DC motor that we will re-use during the coming practicals

Specific Challenges

- A certain sense of meticulousness might be needed for an optimal result
- You'll get your hands dirty
- (and you'll need to use a soldering iron)

Note

In your lab journal, **describe the basic design of each component**, **how it was constructed** and **how it was tested**. Add **pictures** and link to **videos** as needed.
Describe as well **the overall system** and how it performs.

And do not forget: **write your lab journal as a text file using the Markdown syntax** and **push your journal and the pictures on GitHub**.

Figure 1: Commutator constructed from cork and 2 pieces of copper tape

Part I

Build a brushed DC electrical motor

In this assignment you will build a brushed DC motor from first principles. Photos of a suggested design are provided in each section.

You need to build the motor working in pairs. You will be supplied with a wooden base, a cork, and copper tape and about of 10m enamelled copper wire. In addition you are provided with some paper clips, screws and washer to hold everything together. You also will be supplied with 4 neodymium magnets.

Step 1 – Build a commutator

- You have been supplied with a cork and adhesive copper tape.
- Attach the tape so it can be used to form a commentator
- You may need sell tape to increase the strength of the design

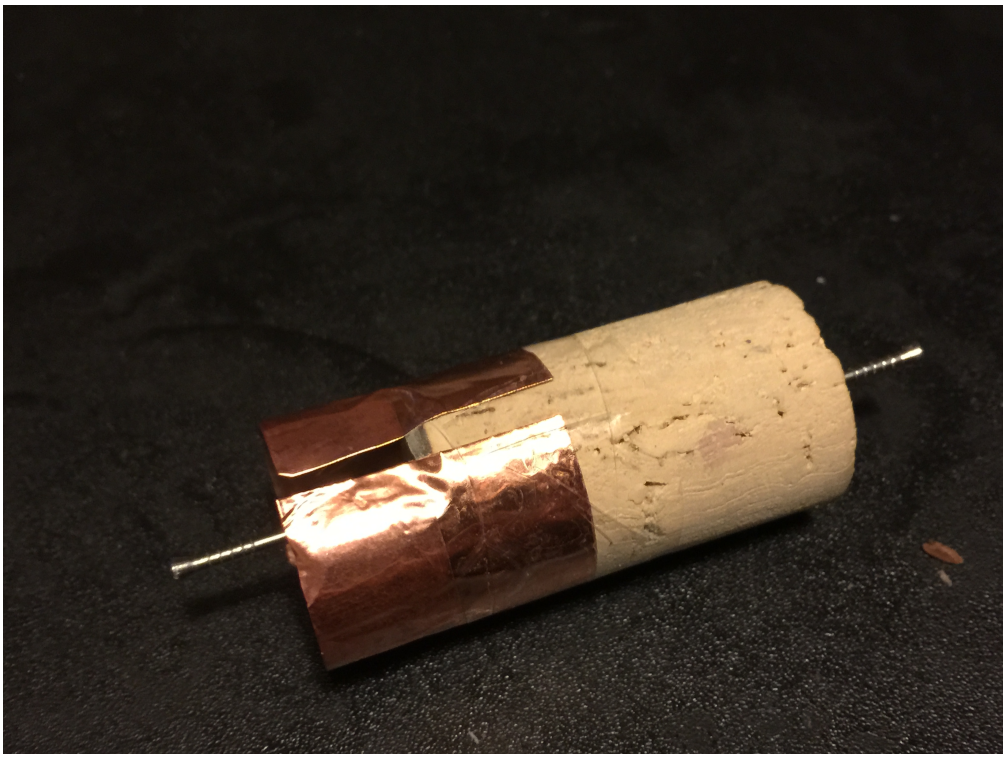

Figure 2: Adding pins in armature to provide a shaft for rotation

Step 2 – Add support shaft

- You have been supplied with two pins.
- Press then into opposite sides of the cork to provide a main shaft for the armature
- Be careful not to damage the commutator!

Step 3 – Wind the armature coil

- You have been supplied with about 10m of enamelled copper wire
- Wind the wire around the cork.
- Use sellotape to fix it down. Record how many turns you use. It should be at least 60 turns and preferably more.
- Make sure both ends of the wire will remain accessible.
- Use sandpaper to remove the enamel at the ends
- Solder the end of the coil wires onto the copper commutator sections
- Measure the resistance of the coil.

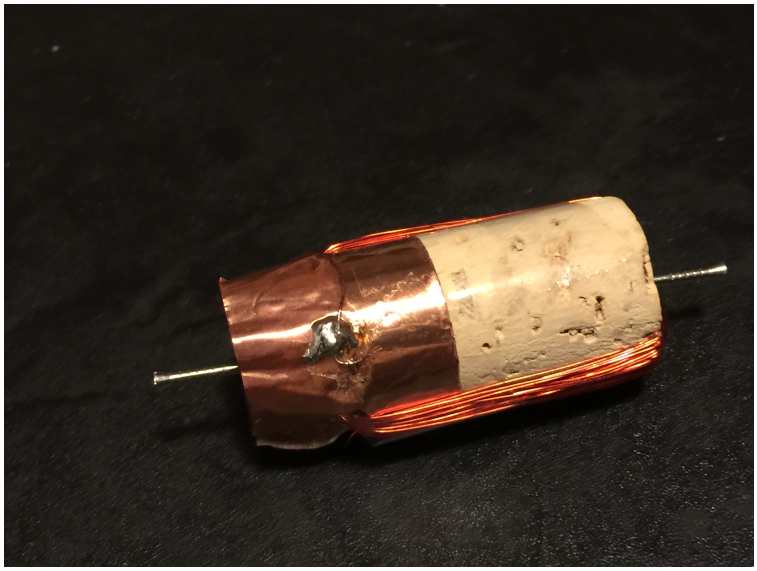

Figure 3: Wind about 10m of thin copper wire around the cork to provide motor coil. Solder the ends to the copper commutator.

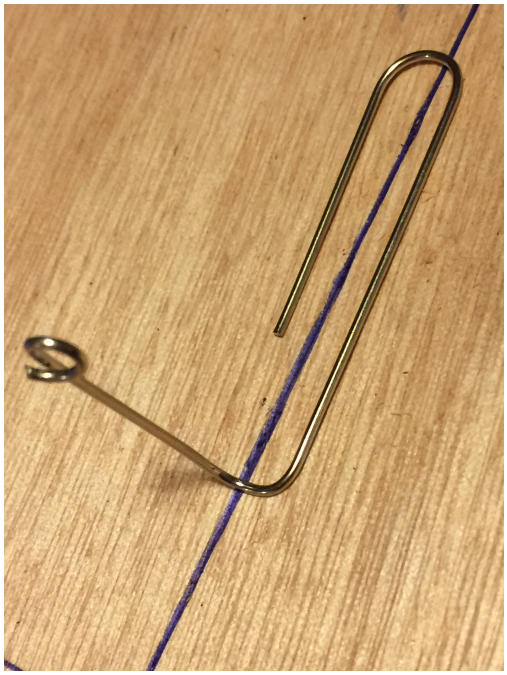

Figure 4: Bend a paperclip to make 2 support bearings for the armature.

Step 4 – Build the shaft support and magnet brackets

- You have been supplied with 4 large paperclips
- Bend 2 of them so they will support the armature and allow it to rotate
- Bend another 2 so they will support the neodymium magnets

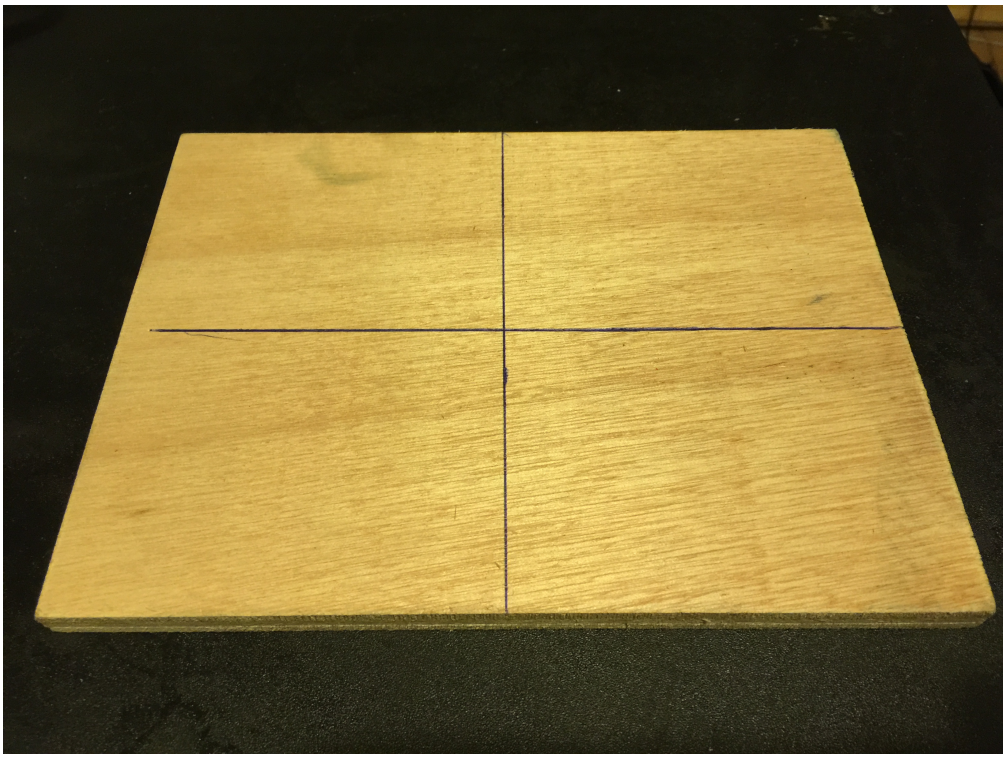

Figure 5: Mark out the baseplate with perpendicular alignment lines through its centre point.

Step 5 – Build the baseplate

- Mark out the baseplate;
- Provide perpendicular alignment lines through its centre point;
- Correctly align all these parts;
- Attach them to baseplate using the provided screws and washers;
- Add the magnets.

Refer to figure 6 for the final assembly.

Figure 6: Correctly align all that parts and screw them down to baseplate using screws and washers provided. Add magnets and then apply power to the commutator with stripped copper wires.

Part II

Test the motor

Step 1 – Finish the motor

1. Apply power to commutator with copper wires;
2. Connect the coil to the power supply provided;
3. Notice that the power supply current is limited to 2A;
4. Be careful that the coil does not get too hot!
5. Touch wires to act like brushes on the commutation.

Step 2 – Test the motor

- Does the armature rotate?

- Can you measure rotational speed using modulation in armature current?
- How fast does the motor rotate at a given applied voltage?

You might want to plot the current as a function of the voltage.

Note

This is the right time to update your lab journal:

- take pictures
- save your plots as image
- integrate them to your `journal.md` Markdown journal
- commit and push on GitHub

Part III

A better DC motor

You are now required to build a brushed DC motor **with a minimum of two coils**. You should also build a commutator and brush mechanism so that the motor self starts.

Further ideas to improve your design:

- Can you build an elegant way of holding the brushed to apply current to the commentator?
- Can you improve the way the armature rotates by using better bearings?
- How would increasing the number of turns of wire affect motor characteristics?
- Consider this in terms of speed, torque and current consumption.

You may not use parts from commercially made motors in your designs!

You will gain marks for improvements to the original design. For example, by maximizing the magnetic flux passing through the armature coils or improving the motor support and bearings.

Use your own ingenuity to come up with a design. We cannot provide financial support for parts but you can use things you can find yourselves. In previous years students made use of the machine shops and 3D printing facilities during this project and some of the final motors constructed were very impressive!

You will gain marks by using a thorough test procedure and by documenting you motor's characteristics.