CSE 4355/5355 - Mechatronics Lab 1

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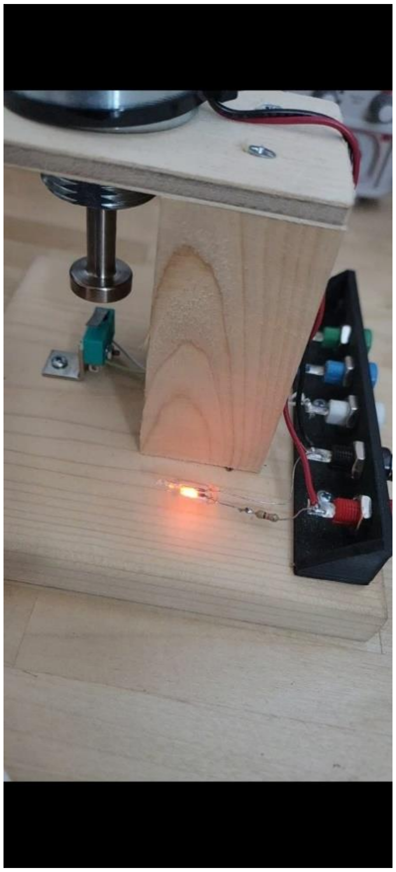
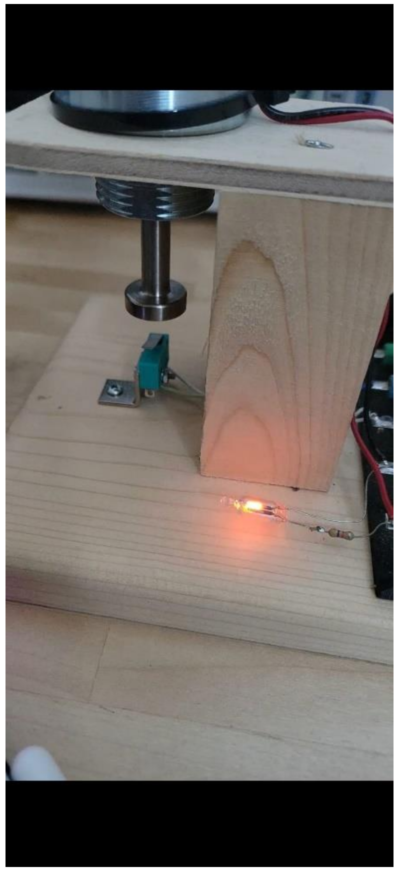
Step 4:

Regular Power Supply: Anode glows when power supply is disconnected. Back EMF is negative.



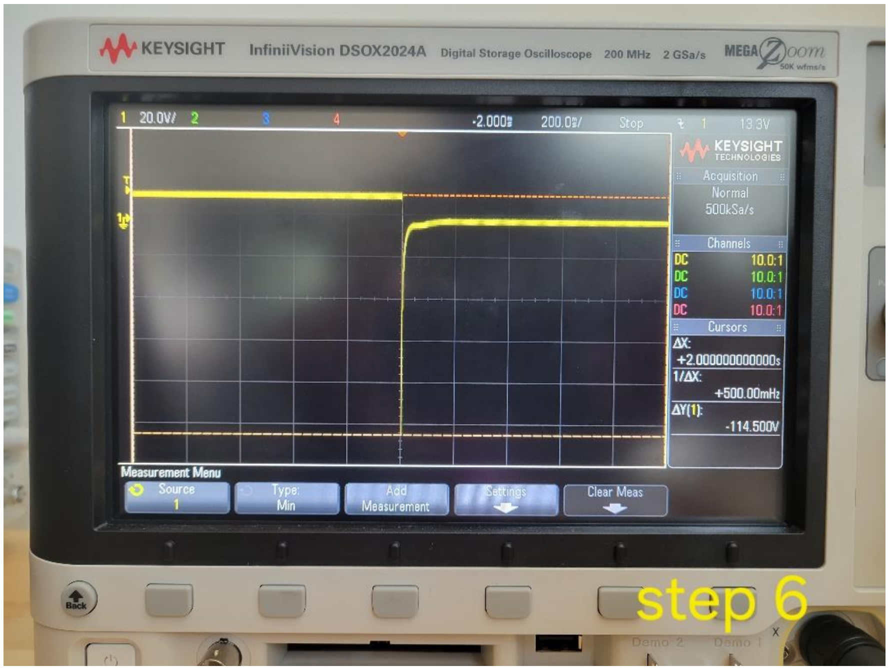
Reversed Power Supply: Cathode glows when power supply is disconnected. Back EMF is positive.



Explanation: Back EMF always opposes the direction of power supply. Hence in step 4, when the power supply is connected conventionally, the back EMF flows from the -ve terminal to the +ve terminal of the solenoid coil, and from the +ve terminal to the -ve terminal when the direction of power supply is reversed. Back EMF occurs because the coil being energized is also capable of generating power when the driving voltage is removed.

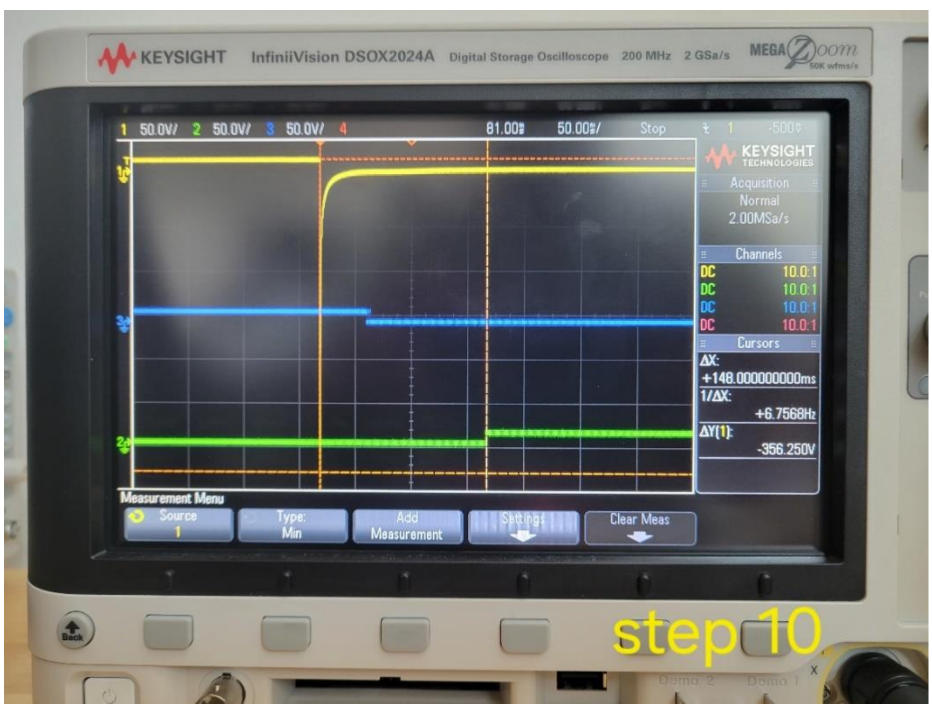
Step 6:

Observation of the Back EMF on the oscilloscope.



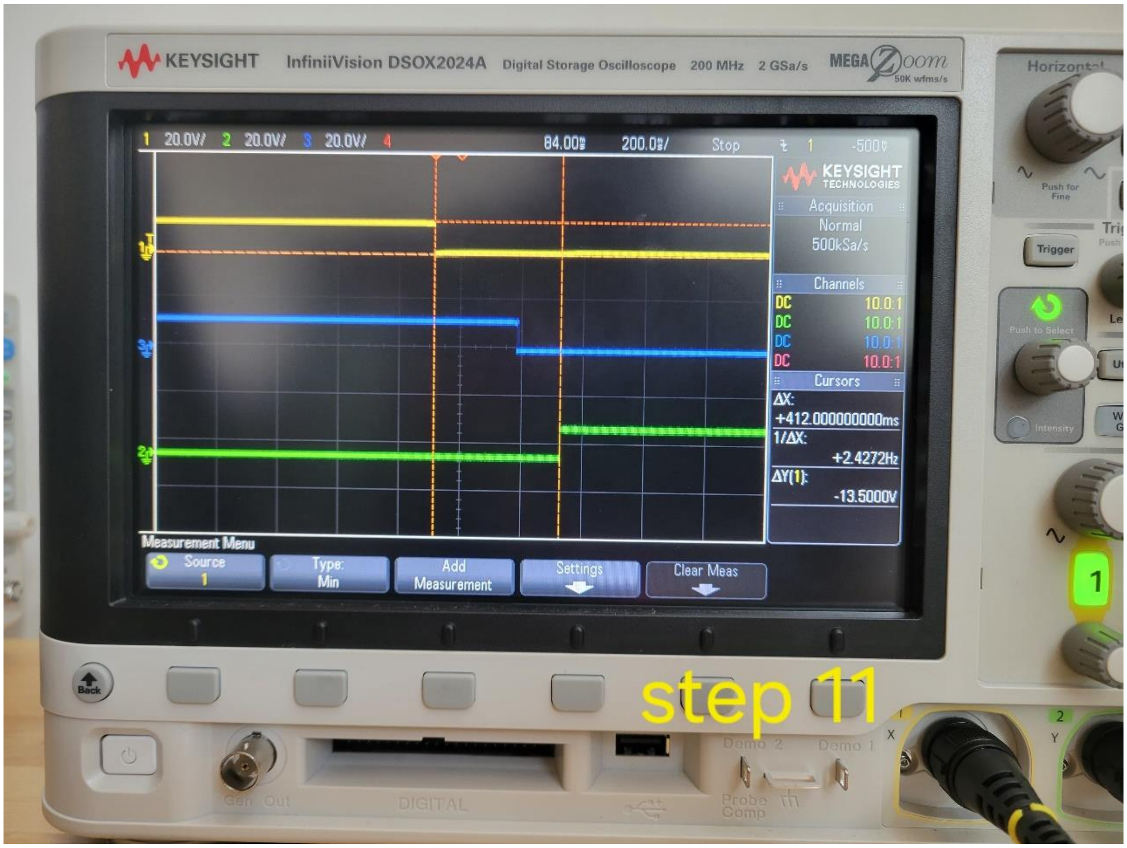
Step 10:

Observation of the Back EMF with the switch activations recorded as the coil is energized.



Step 11:

Observation of the Back EMF with a Schottky Diode (1N5819) connected across the solenoid coil.



Effect of the Flyback Diode:

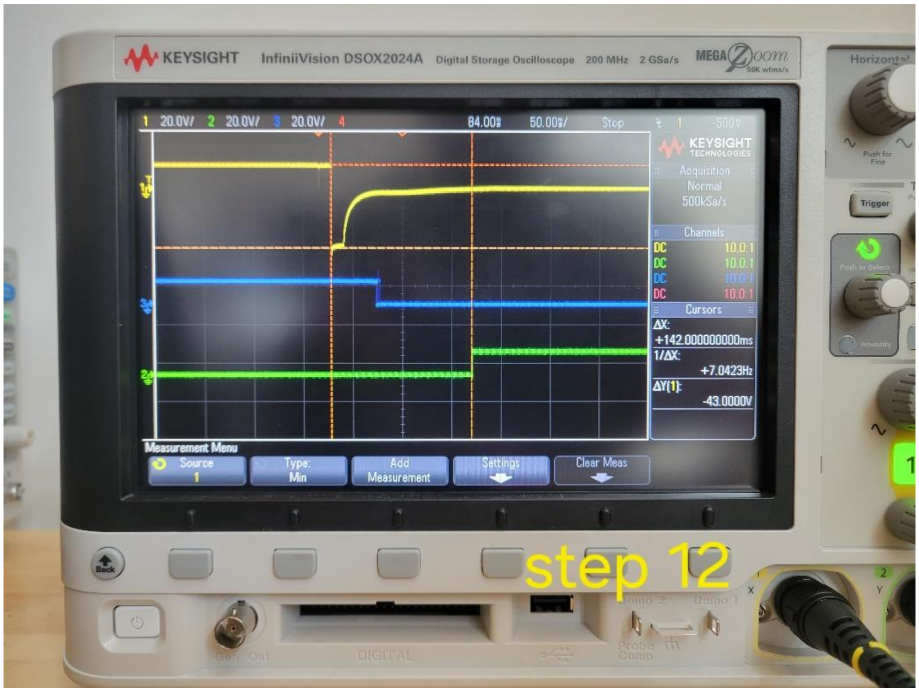
With the diode in place, there is a **reduced voltage spike** in the oscilloscope trace compared to when the solenoid was operated without the diode. The diode shortens the high-voltage pulse, protecting the circuit from the potential damage caused by the back EMF.

Solenoid Release Time:

The Schottky Diode causes the Solenoid to release slower compared to without the Diode. The release time is instant in the absence of the diode. This is because the lower Back EMF voltage doesn't dissipate quickly in the solenoid coil and takes some time to settle to 0V.

Step 12:

Observation of the Back EMF with a pair of Zener Diodes (12V and 18V) in series with a Schottky Diode connected across the Solenoid Coil.



Effect on Release Time and Back EMF Voltage:

- **Back EMF Voltage**: With the Zener diodes in place, the voltage spike observed on the oscilloscope is **higher** than in Step 11 (when only the Schottky diode was used). This is because the Zener diodes allow the voltage to rise until it reaches their combined breakdown voltage before they conduct, which limits the maximum back EMF voltage.
- **Solenoid Release Time**: The release time of the solenoid is seen to **decrease** with Zener diodes in the circuit. This release time is **shorter than the Schottky Diode only circuit in step 11, but not nearly as instant as in a circuit without the Diode** as in **steps 6** and **10**. This is because the higher back EMF voltage allows the magnetic field in the solenoid to collapse more quickly, resulting in faster release of the solenoid plunger.

Step 15:

Observation of the fastest possible rate of energizing and de-energizing the Solenoid Coil with a Schottky Diode.

Wait times to Energize and De-energize the Solenoid Coil:

61ms to de-energize the coil.

190ms to energize the coil.

Step 16:

Observation of the fastest possible energizing and de-energizing of the Solenoid Coil with a Zener (18V) and Schottky Diode connected in series across the Coil.

With the Zener diode in place, the back EMF voltage generated when the solenoid is de-energized is higher (as seen in Step 12). This affects how quickly the solenoid releases and how much current flows through the coil.

Wait times to Energize and De-energize the Solenoid Coil:

65ms to de-energize the coil.

100ms to energize the coil.

Picture of entire circuit: