Faraday Rotation

In this lab you will measure the Faraday Effect using two techniques:

Part 1: DC method:

Follow Teachspin labscript for this part.
Note: we will be using a stand-alone PIN Si photodetector with a separate transimpedance amplifier. For the DC part you only need to use the DC output from this amplifier.
Use the red laser provided by TeachSpin. You should use an additional linear polarizer to reduce the output intensity of the laser before passing through the sample/coil.

Part 2: AC method:

Read the paper by Jain et al. (web site) to get the basic idea. Our setup is very similar with the important distinction that we use only a single coil.

Additional equipment for the AC measurements

- Lockin amplifier (see pdf files on web site on how lockin amplifiers work)
- Audio amplifier to apply AC current to Teachspin coil
- Various coloured LEDs to measure the Verdet constants as a function of wavelength
- Additional polarizer to polarize the various coloured LEDS (unlike the laser, their output is unpolarized)
- 1 microFarad capacitor to form LC circuit containing the Faraday coil.
- Function generator to generate sine wave for the audio amplifier input
- Small spectrometer to measure LED wavelengths

Note: In this part you will use both the ac and dc outputs of the transimpedance amplifier. The sensistivity in V/A is not the same for the DC and AC outputs. Read the numbers on the knob carefully!!

Suggested procedure:
Start by feeding a small sinusoidal voltage (1mV) into the lockin in order to understand how it works. You will need to feed a reference signal from the function generator into the reference input. Investigate the role of the phase control. Investigate the relationship between the DC output of the lockin and the sinusoidal signal that you apply to the input.

Things to measure:
Measure the Verdet constant of glass rod again using the polarized laser and the ac method. Compare your answer with that of the DC method. What angle should the second polarizer be with respect to the first polarizer for maximum signal?
Repeat using the unpolarized LEDs. This is more challenging. Can you see a variation with wavelength? Be careful to establish that your lockin signal is actually signal and not spurious pickup from the coil. How can you distinguish between the two?

Additional possibilities:
Measure the Faraday rotation for a liquid sample such as water. You can also try adding some paramagnetic ions by mixing an aqueous solution of ferric chloride. This is interesting because you can get a change in the sign of the Verdet constant as the solution changes from diamagnetic to paramagnetic.

Notes:

Read the material safety data sheet (MSDS) for ferric chloride carefully.
The stated solubility limit is 90g/100ml at room temperature, but this seems high.
Try a maximum concentration of ~30g/100ml and vary the concentration by dilution.