EXPERIMENT 3
LASER SPECIFICATIONS

PURPOSE

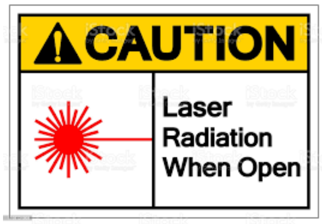
You will perform several experiments to obtain the following specifications of a diode laser: optical power, waste power, beam divergenge, electrical power, I-V curve and spectral distribution.

EQUIPMENT

Variable DC source, optical powermeter, spectometer, multimeter, millimetric paper.

NOTE

Lasers can cause damage in biological tissues, both to the eye and to the skin. Unprotected Human Eye is extremely sensitive to laser radiation and can be permanently damaged from direct or reflected beams. High power lasers can also burn the skin. There are some government regulations that define classes of laser according to the risks associated with them.



THEORY

The term laser stands for Light Amplification by Stimulated Emission of Radiation. A laser is a device that emits light through a process of optical amplification based on the stimulated emission of photons. Light from a laser is coherent, monochromatic and collimated light. A Laser light can be visible, infrared, ultraviolet or X-ray.

Laser beam divergence is an angular measure of the increase in beam diameter distance from the optical aperture from which the beam emerges. Laser is highly collimated and may have very small beam divergence in the order of mrad. Specifications of an example laser pointer is shown in Table 1. In this experiment, we will try to measere some of them.

Table 1: A typical laser specifications

Specifications	
Wavelength	593.5 ±1 nm
Output Power	5 – 20 mW
Transverse Mode	TEM_{00}
Operating Mode	CW
Beam Divergence (full angle)	< 1.5 mrad
Beam Diameter (at the aperature)	~ 1.5 mm
Power Supply	1 x 18650 Li-Ion battery (included)
Expected Lifetime	5000 hours
Max. continuous ON time	**30s**
Warranty period	6 months

An optical power meter (OPM) is a device used to measure the power in an optical signal. A typical optical power meter consists of a calibrated sensor, measuring amplifier and display. An example is shown in Figure 1. The sensor (or detector) primarily consists of a photodiode selected for the appropriate range of wavelengths and power levels. On the display unit, the measured optical power and set wavelength is displayed. Power meters are calibrated using a traceable calibration standard.

We use spectro-photo-meter to extract the relative spectral power distribution (intensity) of a light source as a function of wavelength,. An example, that we have used in lab, is shown in Figure 2. The light data can be taken via a fiber cable. The wavelength range covers UV to NIR (200-1000 nm).

Figure 1: a typical powermeter and its detector used in optics lab.

Figure 2: A CCD spectro photo meter its fiber. It is directly connected to a computer via USB cable.

Current and Voltage (I-V) data of a laser can be displayed by means of simple multimeter. A typical I-V curve of a laser is shown in Figure 3.

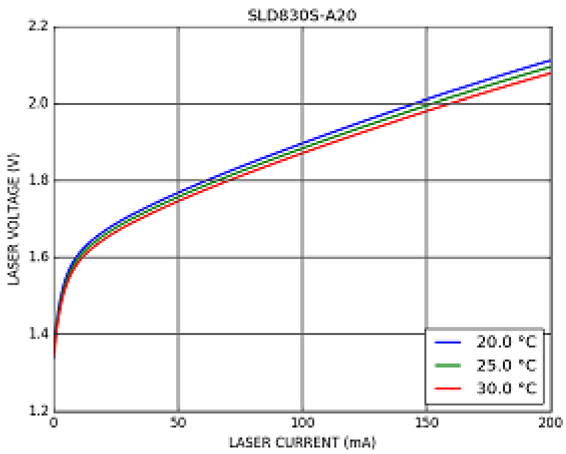


Figure 3: I-V cureve of a laser as a function of temperature.

PROCEDURE

Part 1 *Spectral Light Distribution*

Setup is shown in Figure 4. First connect spectrophotometer (SPM) to computer via USB. Then, turn on the laser and direct its output to the SPM. Finally, observe the spectral light data in computer. Save data to a file.

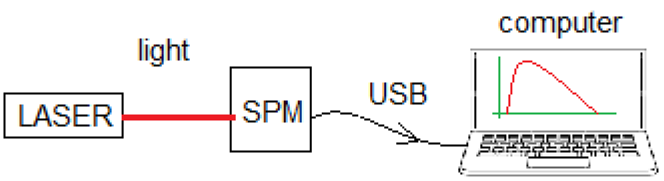


Figure 4: Exp. 1

Part 2 *Power Measurements*

Setup is shown in Figure 5. Laser is connected to a variable DC source. You can measure current and voltage supplied to the circuit via multimeter. Laser's optical power is measured by the powermeter. Fill Table 2.

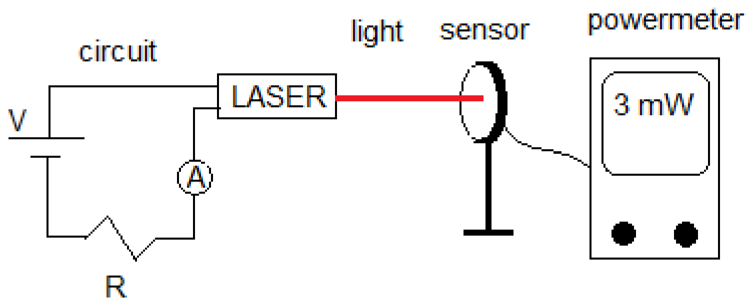


Figure 5: Exp. 2

Part 3 *Beam Divergence*

Setup is shown in Figure 6. The divergence (θ) of a beam can be calculated if one knows the beam diameter at two separate points far from any focus (D1, D2), and the distance (L) between these points (known as far field measurement). Measure D1, D2 on the millimetric paper and distance L to obtain θ via basic trigonometry. Note that the distance L must be at least 2 m. Fill Table 3.

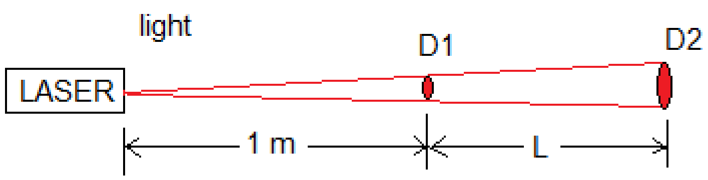


Figure 6: Exp. 3

QUESTIONS

1. Plot the spectral distribution of the laser. Determine peak wavelength and FWHM value of the distribution.
2. Plot I-V curve.
3. Plot P vs Φ data.
4. Plot P vs W data.
5. Determine the beam divergence of the laser.

Table 1: Data for Exp 2

Current, Ampere I	**Voltage, Volts V**	**Electrical power P = I*V**	**Optical Power (W) Φ**	**Waste power W = Φ / P**

Table 3: Data for Exp 3

Diameter 1 D1 (m)	**Diameter 2 D2 (m)**	**Distance L (m)**	**Beam divergence** θ (rad)	**Beam divergence** θ (deg)