Optical Devices and Definitions for MOT

Bode plot - a graph of the frequency response of a system. It is usually a combination of a **Bode magnitude plot,** expressing the magnitude (usually in decibels) of the frequency response, and a **Bode phase plot,** expressing the phase shift. Both quantities are plotted against a horizontal axis proportional to the logarithm of frequency. Given that the decibel is itself a logarithmic scale, the Bode amplitude plot is log–log plot, whereas the Bode phase plot is a linear-log plot. The plot is only an asymptotic approximation of the frequency response, using straight line segments. Plots to show the gain margin and phase margin required to maintain stability under variations in circuit characteristics caused during manufacture or during operation and offer analysis in the frequency domain.

Nyquist stability criterion - a graphical technique for determining the stability of a dynamical system. Because it only looks at the Nyquist plot of the open loop systems, it can be applied without explicitly computing the poles and zeros of either the closed-loop or open-loop system (although the number of each type of right-half-plane singularities must be known). As a result, it can be applied to systems defined by non-rational functions, such as systems with delays. In contrast to Bode plots, it can handle transfer functions with right half-plane singularities and there is a natural generalization to more complex systems with multiple inputs and multiple outputs. It's used for designing and analyzing systems with feedback. While Nyquist is one of the most general stability tests, it is still restricted to linear, time-invariant (LTI) systems.

Optical isolator/diode - an optical component which allows the transmission of light in only one direction. It is typically used to prevent unwanted feedback into an optical oscillator, such as a laser cavity. The main component of the optical isolator is the Faraday rotator. The magnetic field, B, applied to the Faraday rotator causes a rotation in the polarization of the light due to the Faraday Effect. The angle of rotation, β, is specifically chosen to give a rotation of 45°.

Waveplate - an optical device that alters the polarization state of a light wave travelling through it. Two common types of waveplates are the half-wave plate, which shifts the polarization direction of linearly polarized light, and the quarter-wave plate, which converts linearly polarized light into circularly polarized light and vice versa. A quarter-wave plate can be used to produce elliptical polarization as well. Waveplates are constructed out of a birefringent material (such as quartz), for which the index of refraction is different for different orientations of light passing through it. The behavior of a waveplate depends on the thickness of the crystal, the wavelength of light, and the variation of the index of refraction. By appropriate choice of the relationship between these parameters, it is possible to introduce a controlled phase shift between the two polarization components of a light wave, thereby altering its polarization. A waveplate works by shifting the phase between two perpendicular polarization components of the light wave. The crystal is cut into a plate, with the orientation of the cut chosen so that the optic axis is parallel to the surfaces of the plate. This results in two axes in the plane of the cut, one fast and one slow, leading to a phase difference between the two components as they exit the crystal.

Electro-optic modulator - an optical device in which a signal-controlled element exhibiting the electro-optic effect is used to modulate a beam of light. The modulation may be imposed on the phase, frequency, amplitude, or polarization of the beam. Modulation bandwidths extending into the gigahertz range are possible with the use of laser-controlled modulators. The electro-optic effect is the change in the refractive index of a material resulting from the application of a DC or low-frequency electric field. This is caused by forces that distort the position, orientation, or shape of the molecules constituting the material. Generally, a nonlinear optical material with an incident static or low frequency optical field will see a modulation of its refractive index. The simplest kind of EOM consists of a crystal, whose refractive index is a function of the strength of the local electric field. That means that if it is exposed to an electric field, light will travel more slowly through it. But the phase of the light leaving the crystal is directly proportional to the length of time it takes that light to pass through it. Therefore, the phase of the laser light exiting an EOM can be controlled by changing the electric field in the crystal. Note that the electric field can be created by placing a parallel plate capacitor across the crystal. Since the field inside a parallel plate capacitor depends linearly on the potential, the index of refraction depends linearly on the field, and the phase depends linearly on the index of refraction, so the phase modulation must depend linearly on the potential applied to the EOM. The voltage required for inducing a phase change of π is called the half-wave voltage. It is usually hundreds or even thousands of volts, so that a high-voltage amplifier is required. Suitable electronic circuits can switch such large voltages within a few nanoseconds, allowing the use of EOMs as fast optical switches.