Name: _____ **Laser and Optical Technology/Technician**

Directions:
Evaluate the student by entering the appropriate number to indicate the degree of competency achieved.

Rating Scale (0-6):
   0   **No Exposure** – no experience/knowledge in this area; program/course did not provide instruction in this area
   1   **Unsuccessful Attempt** – unable to meet knowledge or performance criteria and/or required significant assistance
   2   **Partial Demonstration** – met some of the knowledge or performance criteria with or without minor assistance
   3   **Knowledge Demonstrated** – met knowledge criteria without assistance at least once
   4   **Performance Demonstrated** – met performance criteria without assistance at least once
   5   **Repeated Demonstration** – met performance and/or knowledge criteria without assistance on multiple occasions
   6   **Mastered** – successfully applied knowledge or skills in this area to solve related problems independently

0	1	2	3	4	5	6	**A. Operate Lasers and Related Equipment Safely and Efficiently**	Notes:
							1. Comprehend and follow 14 of the Laser Institute of America's Safety Rules for Lasers.	
							2. Identify Laser Classifications.	
							3. Demonstrate effective use of safety equipment.	
							4. Demonstrate safe handling of chemicals.	
							5. Describe the impact of the laser on the eye.	
							Other:	

0	1	2	3	4	5	6	**B. Describe And Demonstrate Components Of Laser Safety**	Notes:
							1. Describe various eye hazards.	
							2. Describe skin hazards.	
							3. Describe electrical hazards when using lasers.	
							4. Describe chemical hazards when using lasers.	
							5. Describe protection techniques.	
							6. Demonstrate use of first aid skills.	
							7. Demonstrate use of CPR.	
							8. Indicate by diagrams which sections of the eye can be damaged by ultraviolet, visible, near-infrared, and far-infrared laser emissions.	
							9. Define point source and extended source and explain how the light from each is focused on the retina of the eye.	
							10. List the four processes that account for all the light energy striking a surface.	
							11. Describe and state an example of the following three types of reflection.	
							12. Describe laser classifications, based upon their potential hazards.	
							13. List five laser safety precautions applicable to high-energy (including pulsed) laser systems.	
							14. List ten laser safety precautions applicable to high-energy (including pulsed) laser systems.	

0	1	2	3	4	5	6		Notes:
							15. Measure laser light that is reflected from several surfaces in the laboratory, and determine relative eye hazards involved.	
							Other:	

0	1	2	3	4	5	6	**C. Use a Variety of Tools/Equipment to Take Accurate Measurements**	Notes:
							1. Measure out put of laser with light meter.	
							2. Measure angles accurately using a protractor.	
							3. Measure voltage, time and frequency using an oscilloscope and function generator.	
							4. Measure light waves using a spectroscope.	
							Other:	

0	1	2	3	4	5	6	**D. Apply the Principles of Holography and Associated Wave Theory Used to Produce Holograms**	Notes:
							1. Comprehend the principles of holography and associated wave theory used to produce holograms.	
							2. Demonstrate correct procedures for exposing and developing holographic film.	
							3. Identify and assemble equipment necessary to produce holograms.	
							4. Finish hologram.	
							5. Analyze hologram to determine strengths and defects.	
							6. Evaluate hologram and solve problems encountered.	
							Other:	

0	1	2	3	4	5	6	**E. Apply Basic Theories of Wavelength, Light and Optics to the Variety of Industries Using Lasers, Including Manufacturing, Engineering, Telecommunications, Entertainment, Medicine, Construction, and Art**	Notes:
							1. Identify applications and instances of the following: reflection, refraction, diffraction, interference and polarization.	
							2. Identify different elements using spectroscopy.	
							3. Demonstrate the measuring of distances using diffraction.	
							4. Comprehend the working of a spectroscope.	
							5. Identify different types of fiber optics and applications.	
							6. Identify, clean and handle different types of optics.	
							7. Evaluate and solve problems encountered.	
							Other:	

0	1	2	3	4	5	6	F. Produce An H1 And H2 Holograms.	Notes:
							1. Produce single beam reflection holograms.	
							2. Produce a split beam transmission hologram.	
							3. Explain and document the principle of holography.	
							4. Produce white light transmission-Interferometry.	
							Other:	

0	1	2	3	4	5	6	G. Demonstrate Physically, Analytically, And Graphically The Elements And Operation Of A Laser.	Notes:
							1. Define terms for the properties of laser light.	
							2. Define terms that relate to the lasing process.	
							3. Describe in a short paragraph and with a diagram the process of stimulated emission.	
							4. List the four elements of a laser, and state the purpose of each.	
							5. Draw and label diagrams that illustrate the four basic elements of the different types of lasers.	
							6. List the seven safety precautions to be followed when operating a low powered, helium-neon gas laser.	
							7. List the six steps in the operating procedure of a low-powered, helium-neon laser.	
							8. Operate a helium-neon laser safely.	
							9. Remove the cover of a helium-neon laser, and draw and label its components.	
							Other:	

0	1	2	3	4	5	6	H. Demonstrate Physically, Analytically, And Graphically The Elements And Operation Of An Optical Power Meter	Notes:
							1. Define terms relevant to the elements and operation of an optical power meter.	
							2. Determine quantities of irradiance with different combinations of given variables.	
							3. List the four major elements of a photoelectric power meter, and describe the function of each.	
							4. Describe briefly the function of an ambient light shade and attenuator.	
							5. Describe methods for the wavelength calibration of a photoelectric power meter.	
							6. State three precautions necessary when using a photoelectric power meter.	
							7. In the laboratory, determine the power and irradiance of expanded and unexpanded laser beams with an optical power meter.	
							Other:	

0	1	2	3	4	5	6	I. Define, Calculate, And Measure The Properties Of Light	Notes:
							1. Define the terms for describing wave properties of light.	
							2. Define units employed in the measurement of the frequency and wavelength of light.	
							3. Draw and label a sketch of a plane-polarized electromagnetic (E-M) wave at one time at different points along a line in the direction of propagation.	
							4. Define index of refraction.	
							5. Given the index of refraction of a material and wavelength of light in a vacuum, determine its wavelength and velocity inside the material.	
							6. Explain the significance of Brewster's angle; and calculate Brewster's angle, given index of refraction of the material.	
							7. Define temporal coherence and spatial coherence, and state the characteristics of a light source that affect each of these properties.	
							8. Explain constructive and destructive interference.	
							9. With the use of diagrams, explain the operation of an antireflection coating and a high-reflectance coating.	
							10. With a grating spectroscope, measure the range of wavelengths spanned by the visible portion of electromagnetic spectrum of light.	
							11. Measure the extinction ratio of a linearly-polarized HeNe laser beam.	
							12. Measure Brewster's angle, and determine the index of refraction of a microscope slide.	
							13. Produce interference fringes by reflecting a HeNe laser beam from a microscope slide.	
							Other:	

0	1	2	3	4	5	6	J. Calculate, Graphically Represent, And Apply Theories To Determine The Emission And Absorption Of Light	Notes:
							1. Define terms relevant to the emission and absorption of light.	
							2. Given a quantity of energy expressed in relevant units, determine the equivalent expression in other relevant units.	
							3. Calculate frequency, wavelength, and energy of a photon.	
							4. Describe the absorption of a photon by an atom; include the conditions necessary for absorption to occur.	
							5. Describe the spontaneous emission of a photon by an atom.	
							6. Describe the stimulated emission of a photon by an atom; include the conditions necessary for stimulated emission to occur.	
							7. Draw diagrams that depict the emission spectrum of an atomic gas and absorption spectrum of a solid.	
							8. Describe the relationship between atomic lifetime and the intensity of spectral lines.	

0	1	2	3	4	5	6		Notes:
							9. Explain Doppler broadening of a spectral line.	
							10. Given the appropriate equipment, determine the wavelengths of three spectral lines, in mercury, helium, and neon.	
							Other:	

0	1	2	3	4	5	6	K. Calculate, Explain, And Demonstrate Lasing Action	Notes:
							1. Explain the term absorption coefficient and state its units.	
							2. Calculate irradiance incident upon, irradiance transmitted through, and transmission of a material.	
							3. Calculate absorption coefficient, thickness, and transmission of a material.	
							4. Explain with a diagram and in a short paragraph, the exponential law of absorption.	
							5. Describe how the transmission of neutral density, cutoff, and band-pass filters vary with changes in the wavelength of light.	
							6. Given the optical density of a filter, calculate its transmission.	
							7. With the use of diagrams explain normal population distribution and population inversion.	
							8. Calculate gain coefficient of a laser, length of active medium, and amplifier gain.	
							9. Draw a diagram that displays gain as a function of wavelength for typical laser emission line.	
							10. Draw and label the energy-level diagram of four-level laser.	
							11. Explain the energy-transfer processes that increase the population of the upper lasing level in gas lasers and in solid lasers.	
							12. Given the appropriate equipment, measure the transmission of three colored filters at the HeNe laser wavelength; and calculate the absorption coefficient of each.	
							13. Given the appropriate equipment, measure the amplifier again of HeNe laser tube; and calculate the gain coefficient.	
							Other:	

0	1	2	3	4	5	6	L. Define And Calculate Optical Cavities And Modes Of Oscillation	Notes:
							1. Define terms relevant to optical cavities and modes of oscillation.	
							2. Draw, label, and explain a diagram of an optical cavity.	
							3. List and explain four factors that contribute to loss in an optical cavity.	
							4. Calculate loop gain, amplifier gain, reflectivity of HR mirror, reflectivity of output coupler, and round-trip cavity loss.	
							5. Explain with the use of diagrams the gain and output power as a function of time CW and pulsed lasers.	
							6. Draw and label diagrams of seven configurations of laser cavities.	

0	1	2	3	4	5	6		Notes:
							7. Explain the advantages, disadvantages, and applications of each of the seven configurations of laser cavities.	
							8. Calculate cavity length of laser, active length of laser, index of refraction of active medium, and mode spacing.	
							9. Draw, label, and explain diagrams that illustrate the longitudinal modes present in a typical laser output.	
							10. Given the mode spacing of al laser, the round-trip loss and the transmission of the output coupler, determine the approximate bandwidth of a single laser mode.	
							11. Given the mode spacing florescent line-width of a laser, determine the approximate number of modes present in the laser output.	
							Other:	

0	1	2	3	4	5	6	M. Graphically And Analytically Explain And Apply The Theories Involving Temporal Characteristics Of Lasers	Notes:
							1. Define terms relevant to temporal characteristics of lasers.	
							2. Prepare graphs that describe the output of the following types of laser pulses as functions of time.	
							3. Draw graphs of amplifier gain, loop gain, and output power as functions of time in a Q-switched laser.	
							4. Explain briefly the term "mode-locking".	
							5. Calculate pulse duration, peak pulse power, and energy per pulse.	
							6. Calculate average power, peak power and duty cycle.	
							7. Calculate pulse repetition rate, pulse duration, and duty cycle.	
							8. Calculate average power, pulse repetition rate, and energy per pulse.	
							9. Calculate frequency bandwidth of laser output and longitudinal coherence length.	
							10. Explain the practical significance of longitudinal coherence length.	
							Other:	

0	1	2	3	4	5	6	N. Demonstrate, Explain, And Apply The Spatial Characteristics Of Lasers	Notes:
							1. Sketch selected transverse electromagnetic modes of a laser.	
							2. Explain briefly the origin of transverse electromagnetic modes in a laser, and explain how unwanted higher-order modes can be eliminated.	
							3. Draw and label a diagram of the irradiance of the TEM00 mode as a function of distance across the beam.	
							4. Explain the meaning of spot size and beam diameter at $1/e2$ points.	
							5. List three reasons why the TEM00 mode is the most important mode in practical applications of lasers.	

							6. Given the wavelength of a laser and the diameter of its output aperture, calculate the diffraction-limited beam divergence.	
							7. Given the initial diameter and divergence angle of a laser beam, calculate its diameter at a given distance.	
							8. Given the diameter (or spot size) of a laser beam and the diameter of a circular aperture upon which the beam is centered, calculate the fraction of the power transmitted through the aperture.	
							9. Given the beam diameters at two distances from a laser, determine the beam divergence angle.	
							10. Explain briefly the difference between the "near field" and the "far field" of a laser.	
							11. Draw and label a diagram that illustrates the shape of the optical surfaces of the output coupler of a gas laser, and explain how the coupler reduces beam divergence.	
							12. Given the divergence angle of a laser beam and the focal length of a positive lens used to focus the beam, calculate the diameter of the focused spot.	
							13. Given the appropriate equipment, scan a HeNe laser beam with a small-aperture detector; plot the beam profile; and determine the beam diameter.	
							14. Given the appropriate equipment, measure the transmission of a HeNe laser beam through a circular aperture placed in the beam at two points; and calculate beam diameter at both points and beam divergence angle.	
							Other:	

0	1	2	3	4	5	6	O. Define, Explain and Demonstrate Reflection At Plane And Spherical Surfaces	Notes:
							1. Define light ray.	
							2. Give the conditions for which the light ray representation of light is useful.	
							3. State the law of reflection.	
							4. Show the law of reflection applied to a single light ray by drawing and labeling a figure that includes the reflecting surface or boundary, surface normal, incident ray and angle, and reflected ray and angle.	
							5. Explain the difference between diffuse and specular reflection.	
							6. Show how to locate images of an extended object in a plane mirror.	
							7. Perform an experiment that directly compares pinhole size and the corresponding pinhole shadow size for assorted pinholes illuminated with collimated laser light Relate the results of this experiment to the usefulness of geometrical optics (light rays) in predicting pinhole shadow size for pinholes of smaller diameters.	
							8. Verify, experimentally, the law of reflection by performing experiments in which laser light is incident upon plane and spherical surface.	
							Other:	

0	1	2	3	4	5	6	P. Define, Explain, Demonstrate and Calculate Refraction At Plane Surfaces	Notes:
							1. Explain, with a diagram, the law of refraction. Label the incident ray, the refracted ray, the normal to the surface, the angle of incidence, the angle of refraction, the reflected ray, and the refractive indices of two media.	
							2. Define relative index of refraction and absolute index of refraction.	
							3. Given three of the following quantities, calculate the fourth using Snell's law:	
							a. Angle of incidence	
							b. Angle of refraction	
							c. Refractive index of medium 1	
							d. Refractive index of medium 2	
							4. State which way light will be bent in going from a less dense medium into a denser medium, or vice versa.	
							5. Define total internal reflection, using a diagram to illustrate your definition. Describe TIR in a Porro prism.	
							6. Calculate the critical angle of a material, given its refractive index.	
							7. Calculate the displacement of a light beam by a glass plate, given its thickness, refractive index, and the angle of incidence to the beam.	
							8. Compute the refractive index of a prism, given its apex angle and the minimum deviation angle.	
							9. Define color dispersion. Explain why shorter wavelengths of light will be bent more than longer wavelengths in being refracted by a prism.	
							10. Calculate the apparent depth of an object below the plane surface of a medium of known refractive index, when you know the actual depth.	
							11. Operate a helium-neon laser and perform these tasks:	
							a. Set up and illustrate the law of refraction	
							b. Measure the index of refraction of a piece of plastic (within ± 15% of the instructor's measurement of the index of refraction of the plastic)	
							12. Measure the displacement of the laser beam due to refraction after it passes through the plastic in Objective 11. Compare the result with the computed value.	
							Other:	

0	1	2	3	4	5	6	Q. Define, Explain, Demonstrate and Calculate Refraction At Spherical Surfaces	Notes:
							1. Define image point, real image, virtual image and paraxial ray.	
							2. Illustrate the refraction of a ray at a spherical surface by sketching the center of curvature, at normal to the point of incidence and the refracted ray.	
							3. Distinguish between concave and convex surfaces.	
							4. Calculate the image position and magnification for a small object located anywhere on the axis of a refracting spherical surface.	

								Notes:
							5. Explain the sign convention to be used in calculation image locations and magnifications for refraction from a spherical surface.	
							6. Explain how refraction calculations are handled in tandem.	
							7. Explain the occurrence of a virtual object.	
							8. With appropriate equipment as provided and for a given light ray incident in air upon a plane surface of some optical material with refractive index n, determine the angle of refraction of a given light ray analytically (from Snell's law), and the angle of refraction of the given light ray experimentally.	
							Other:	

0	1	2	3	4	5	6	R. Define, Determine and Describe Imaging With A Single Lens	Notes:
							1. Define a thin lens and explain the conditions that must be met before a lens can be treated as a thin lens.	
							2. Define converging lens and diverging lens. Be able to illustrate several types of each with drawing.	
							3. Identify the following lens types: equi-convex, plano convex, positive meniscus, equi-concave, plano concave, negative meniscus.	
							4. Define the primary focal point of a thin lens, the secondary focal point of a thin lens, and focal plane.	
							5. Determine image location and size of an object of an object placed before either a positive or a negative thin lens by each of the following methods: graphical ray tracing, mathematical and experimental.	
							6. Describe and differentiate virtual image and a real image.	
							7. Set up an experimental arrangement for determining the primary and secondary focal points of a thin positive lens and a thin negative lens.	
							Other:	

0	1	2	3	4	5	6	S. Determine and Calculate Imaging With A Multiple Lens	Notes:
							1. Given three lenses, determine analytically, graphically, and experimentally the primary and secondary focal points of each lens.	
							2. Determine analytically, graphically, and experimentally the size and location of the image produced by a dual-lens system consisting of two converging lenses.	
							3. Determine analytically, graphically, and experimentally the size and location of the image produced by a dual-lens system consisting of one converging and one diverging lens.	
							4. Given the object distance and height for an optical system of two lenses of known focal length and placement, determine the position, size and character of the final image, and the lateral magnification, using both mathematical and graphical ray tracing methods	
							5. Given a system of three lenses of known focal length and placement, determine the position of the image.	

							6. Compute the power of a series of thin lenses in contact with one another, given their individual powers.	
							7. Use the Lensmaker's equation to calculate the radius of curvature of a lens, given its power and refractive index.	
							Other:	

0	1	2	3	4	5	6	**T. Define, Determine and Verify F-Stops And Apertures**	**Notes:**
							1. Define field stop and aperture stop. Label these on an appropriate diagram.	
							2. Define entrance and exit pupils Label these on an appropriate diagram.	
							3. Determine, graphically and analytically, the entrance and exit pupils of a lens with a front stop and a lens with a rear stop.	
							4. Define the concept of a chief ray. Illustrate this concept with the aid of a diagram.	
							5. Determine, graphically and analytically, the exit pupil, entrance pupil, and aperture stop for two lenses with a stop placed between them.	
							6. Verify, experimentally, the results obtained above for the system of two lenses with an intermediate stop.	
							Other:	

0	1	2	3	4	5	6	**U. Illustrate, Define, Explain and Set Up Optical Systems**	**Notes:**
							1. Illustrate, with the aid of a diagram, the principle of a simple magnifier, including the concept of the near point of the eye and the character of the image observed.	
							2. Define the lateral magnification and angular magnification of a simple magnifier.	
							3. Given the focal length of a magnifier and the height and distance of an object from the magnifier, calculate its lateral and angular magnification.	
							4. Illustrate, with the aid if a diagram, the working principle of a compound microscope. Label the objective and ocular lenses, along with the primary and secondary focal lengths of the two lenses.	
							5. Define the angular magnification and the overall magnification of a compound microscope.	
							6. Given the focal lengths, the separation of the objective and ocular lenses, and the object height and placement, compute the overall magnification of a compound microscope.	
							7. Draw a diagram that illustrates the principle of the astronomical telescope; label the objective and ocular lenses and their focal lengths and separation, along with the character of the image formed.	
							8. Draw a diagram of the reflecting telescope.	
							9. Calculate the angular magnification of an astronomical telescope, given the focal lengths of the objective and ocular lenses.	
							10. Define or describe for binoculars the exit pupil, entrance pupil, eye relief and field of view.	

							11. Draw two different types of laser beam expanding collimators. One of these collimators will consist of two positive lenses, and the other will consist of one positive and one negative lens. Clearly indicate the placement and focal lengths of the two lenses in each collimator.	
							12. Given the diameter of an unexpanded laser beam and the focal lengths of the two lenses used in either of collimators in Objective 11, compute the diameter of the expanded beam.	
							13. Explain the use of the aperture stop in conjunction with shutter speed on a camera. Define depth of field for a camera.	
							14. Set up a simple astronomical telescope and a Galilean telescope. Observe the character of the image produced and measure the angular magnification for both telescopes.	
							15. Set up a terrestrial telescope and observe the character of the image produced.	
							16. Set up both Keplerian and Galilean laser collimators and measure the diameter of the expanded beam, comparing it to the calculated value.	
							17. Set up a compound microscope and determine its overall magnification.	
							Other:	

0	1	2	3	4	5	6	V. Demonstrate And Describe Elements Of Basic Electronics	Notes:
							1. Describe the function of resistors.	
							2. Describe the function of transistors.	
							3. Describe the function of diodes.	
							4. Demonstrate the function of resistors.	
							5. Demonstrate the function of transistors.	
							6. Describe the difference between a laser diode and an LED.	
							7. Demonstrate correct use of an oscilloscope.	
							8. Trace a signal on a component.	
							9. Calculate resistor values in series and parallel circuit.	
							10. Verify calculations experimentally.	
							11. Build a simple power supply using diodes, resistors, and capacitors.	
							12. Calculate and build a power supply with specific outputs.	
							Other:	

0	1	2	3	4	5	6	W. Demonstrate Leadership And Teamwork Skills	Notes:
							1. Demonstrate leadership qualities during projects and labs.	
							2. Demonstrate the ability to work cooperatively in a small group.	
							Other:	

0	1	2	3	4	5	6	X. Demonstrate The Ability To Produce And Sell A Product	Notes:
							1. Use a Problem Based Learning technique to develop a business strategy.	
							2. Develop a product from surveys written by the students.	
							3. Produce a professional quality product based on survey information.	
							4. Document daily progress and changes in manufacturing process.	
							5. Develop and implement advertising and sales strategies.	
							6. Document final results, individual responsibilities, successes, and shortcomings of the business.	
							Other:	

0	1	2	3	4	5	6	Y. Develop A Project From Information Researched And Apply That Knowledge To Complete The Chosen Application	Notes:
							1. Demonstrate the ability to formulate an idea, research information, and create a product.	
							2. Solve problems associated with project.	
							3. Demonstrate ability to work towards a deadline.	
							4. Use current trade journals.	
							5. Document all aspects of project with a technical paper, logbook entry, presentation, and demonstration (if possible) of project.	
							6. Demonstrate of project to class.	
							7. Post results on a web-page.	
							Other:	

0	1	2	3	4	5	6	Z. Operate Computers and Related Peripherals	Notes:
							1. Conduct research.	
							2. Create laser light shows.	
							3. Cut and etch materials.	
							4. Demonstrate the ability to use a word processing program.	
							5. Demonstrate the ability to use the Internet for an information search.	
							6. Demonstrate the ability to use draw programs.	

							7. Demonstrate the ability to use X-29 Lite.	
							8. Demonstrate the ability to post to a web page.	
							Other:	

0	1	2	3	4	5	6	AA. Communicate Effectively in Both Written and Oral Modes	Notes:
							1. Prepare and give oral presentations to classmates, teachers and visitors.	
							2. Use a specified record-keeping technique to document work performed.	
							Other:	

0	1	2	3	4	5	6	BB. Apply Pre-employment Skills to Obtain Fictitious Positions	Notes:
							1. Apply job search techniques.	
							2. Demonstrate telephone skills for obtaining information.	
							3. Prepare a resume.	
							4. Prepare a job application form.	
							5. Produce letters of application.	
							6. Demonstrate proper grooming and hygiene.	
							7. Keep current with new discoveries of applications in laser technology.	
							Other:	

0	1	2	3	4	5	6	CC. Demonstrate The Use Of Scientific Methods.	Notes:
							1. Demonstrate the use of problem-solving techniques.	
							2. Demonstrate the ability to analyze data.	
							3. Recognize and identify different patterns in data.	
							4. Demonstrate the use of observation techniques.	
							5. Demonstrate use of various documentation methods: logbook, oral, graphics, and computer programs.	
							Other:	

0	1	2	3	4	5	6	R. Demonstrating Leadership	Notes:
							1. Demonstrate an understanding of Skills USA/VICA, its structure, and activities.	
							2. Demonstrate an understanding of one's personal values.	
							3. Perform tasks related to effective personal management.	
							4. Demonstrate interpersonal skills.	

							5. Demonstrate etiquette and courtesy.	
							6. Demonstrate effectiveness in oral and written communication.	
							7. Develop and maintain a code of professional ethics.	
							8. Perform basic parliamentary procedures in a group meeting.	
							Other:	