Strand 2: Technical Knowledge and Skills

2.A Safety in the Biotechnology Laboratory

2.A.01 Complete and obtain a 10-hour OSHA certification

2.A.01.01 Complete the requirements of OSHA 10 hour certification course and receive a course completion card.

2.A.01 Performance Example:
- Complete 10hr OSHA certification course.

2.A.02 Complete and obtain a CPR and First Aid Training card/credential.

2.A.02.01 Complete American Red Cross or American Heart Association Heart saver First Aid and CPR AED certification and receive a course completion card.

2.A.02 Performance Example:
- Complete First Aid and CPR AED Training

2.A.03 Follow safety and emergency procedures according to OSHA standards.

2.A.03.01 Practice work habits that provide personal safety, safety for others, and protect the safety and security of the external environment.

2.A.03.02 Select and use appropriate personal protective equipment at all times.

2.A.03.03 Maintain a sanitary and clutter-free work environment.

2.A.03.04 Monitor, use, store, and dispose of materials according to established procedures.

2.A.03 Performance Example:
- Students will use PPE at all times when working in the lab .according to OSHA standards.
- Students will wipe down work areas with 70% ethanol or a freshly prepared 1/10 dilution of bleach prior to and after working with bacteria.

2.B Basic Biotechnology Knowledge and Skills

2.B.01 Demonstrate knowledge of biotechnology industry fundamentals.

2.B.01.01 Describe the major application areas of biotechnology and their products.

2.B.01.02 Describe the life cycle of products (e.g., research and development to production).

2.B.01.03 Describe the organizational structures of biotechnology companies.

2.B.01.04 Summarize the historical development of biotechnology.

2.B.01.05 Describe the social, legal, and ethical issues that affect the application of biotechnology.

2.B.01.06 Use and interpret information resources relevant to biotechnology (e.g., journals, databases, website, etc.).

2.B.01.07 Explain the different career paths in biotechnology and the jobs associated with them.

2.B.01 Performance Example:
- Student will analyze a teacher provided case study which addresses the moral, ethical, and medical issues surrounding the treatment of a young child suffering from a rare genetic disorder.
- Student teams will debate the bioethical concerns surrounding the use of genetic diagnosis, stem cells, and in-vitro fertilization.

2.B.02 Demonstrate knowledge of regulatory affairs.

- 2.B.02.01 Explain good documentation practices (e.g., signatures, dating, use of indelible ink, witnessing requirements).
- 2.B.02.02 Explain the history of pharmaceutical regulations and the Food and Drug Administration (FDA).
- 2.B.02.03 Explain the organization of the FDA (e.g., the roles of Center for Drug Evaluation and Research (CDER) and Center for Biologics Evaluation and Research (CBER)).
- 2.B.02.04 Explain the life cycle of medical products (e.g., discovery through clinical trials, New Drug Application (NDAs), Investigational New Drug (INDs).
- 2.B.02.05 Explain current Good Manufacturing Practice (cGMP) and Good Laboratory Practice (GLP) regulations.
- 2.B.02.06 Explain the regulatory agencies at the local, state and federal levels.
- 2.B.02.07 Document assay procedures and results.
- 2.B.02.08 Evaluate results of assays (e.g., determine amount of analyte in quantitative assay).
- 2.B.02.09 Prepare results in written technical reports (e.g., designated report format is used, all resources are referenced, graphs and tables are clearly labeled and explained, data is accurately analyzed) and present orally.
- 2.B.02.10 Explain the roles of the IBC and IUCAC.
- 2.B.02.11 Explain United States Department of Agriculture (USDA) an Public Health Service (PHS) Policy on the humane care and use of laboratory animals and the roles of the American Association for Laboratory Animal Science (AALAS) and Association for Assessment and Accreditation of Laboratory Animal Care (AAALAC).

2.B.02 Performance Example:

- Prepare a PowerPoint presentation to explain the history of the FDA.
- Document assay procedure and results in a laboratory notebook

2.B.03 Demonstrate basic lab management skills.

- 2.B.03.01 Inventory supplies according to established procedures.
- 2.B.03.02 Obtain required materials.
- 2.B.03.03 Schedule work functions in an organized manner.
- 2.B.03.04 Clean and sterilize glassware and counters according to preestablished procedures.
- 2.B.03.05 Ensure that equipment is cleaned and maintained according to established preventative maintenance procedures.
- 2.B.03.06 Document lab support functions using logbooks, computer systems, forms, and other methods, according to established procedures (e.g., autoclave, pH meter, incubators and freezers).

2.B.03 Performance Example:

- An instructor designated student will act as a lab supervisor for the day. The student supervisor will assign lab maintenance duties (inventorying supplies, cleaning glassware, and equipment, media prep, et cetera), verify they are completed properly and review logbook entries that document all completed tasks for the day.
- Use a logbook to document use of equipment (i.e., autoclave).

2.C Biomanufacturing Fundamentals

2.C.01 Demonstrate and apply manufacturing process management techniques.

- 2.C.01.01 Identify, create and use standard operating procedures (SOPs).
- 2.C.01.02 Explain how process control data is used to monitor processes.
- 2.C.01.03 Test product to verify that it meets specifications and regulations.
- 2.C.01.04 Explain biomanufacturing lean techniques as they pertain to improved efficiency, reduction of waste and increased productivity.
- 2.C.01.05 Identify and apply the concepts of total quality management appropriate to the field.
- 2.C.01.06 Develop a comprehensive product development plan for a biotechnology product.

2.C.01 Performance Example:

- Create an SOP for the operation of a piece of lab equipment.
- Choose a biotechnology product and develop a CPDP.

2.D Solution Preparation

2.D.01 Perform basic calculations.

- 2.D.01.01 Perform calculations relating to measurements.
- 2.D.01.02 Perform calculations relating to reagent and media formulation and dilution.
- 2.D.01.03 Perform calculations relating to data acquisition and analysis.
- 2.D.01.04 Perform calculations relating to products, processing and quality control monitoring.
- 2.D.01.05 Perform calculations relating to growing cells and analyzing their growth rate.
- 2.D.01.06 Determine concentrations of solutions.
- 2.D.01.07 Graph and interpret data using electronic spreadsheet programs.
- 2.D.01.08 Perform calculations relating to dosage levels for animal studies (e.g., mg/kg, ml/kg).

2.D.01 Performance Example:

- Calculate the concentration of a copper sulfate solution.
- Create a standard curve graph using an Excel spreadsheet.

2.D.02 Prepare solutions.

- 2.D.02.01 Prepare percent, molar and molal solutions.
- 2.D.02.02 Perform dilutions and calculate resulting concentrations.
- 2.D.02.03 Perform serial dilutions.
- 2.D.02.04 Prepare agar plates and broths using appropriate techniques (filtration or autoclave).
- 2.D.02.05 Label and store reagents, solutions, and media according to established procedures.

2.D.02 Performance Example:

- Students will prepare 15mL of a 7.5% Copper sulfate solution.
- Students will perform four 1:10 serial dilutions of copper sulfate solutions.

2.E Instrumentation and Lab Assays

2.E.01 Metrology: Use measurement instrumentation.

- 2.E.01.01 Calibrate and maintain measuring instruments (e.g., balances, pH meters, thermometers, pipettes, spectrophotometers).
- 2.E.01.02 Make weight measurements with acceptable accuracy and precision.

2.E.01.03 Make volume measurements with acceptable accuracy and precision.
2.E.01.04 Make pH measurements with acceptable accuracy and precision.
2.E.01.05 Make temperature measurements with acceptable accuracy and precision.
2.E.01.06 Make spectrophotometric measurements with acceptable accuracy and precision.

2.E.01 Performance Example:
- Students will demonstrate the ability to choose and use equipment for the measurement of weight, volume, pH, temperature, wavelength and concentration.
- Students will demonstrate the ability to calibrate and maintain equipment such as pH meters, balances, thermometers, pipettes and spectrophotometers.

2.E.02 Use microscopes.
2.E.02.01 Identify microscope parts.
2.E.02.02 Demonstrate use and care of microscopes.
2.E.02.03 Differentiate between the different types of microscopes and describe their uses (compound, inverted, scanning electron, fluorescent, and stereo).
2.E.02.04 Prepare a wet mount slide.
2.E.02.05 Prepare a slide with a cross section.
2.E.02.06 Demonstrate cleaning of the microscope and lenses.
2.E.02.07 Demonstrate basic cell staining techniques to observe cell morphology.
2.E.02.08 Count cells using a hemocytometer.
2.E.02.09 Identify and describe functions of cellular organelles.

2.E.02 Performance Example:
- Students will demonstrate how to prepare a wet mount slide.
- Students will determine the number of cells using a hemocytometer when given a prepared slide.

2.E.03 Perform standard lab assays/techniques.
2.E.03.01 Isolate DNA.
2.E.03.02 Determine DNA concentration and purity.
2.E.03.03 Perform enzyme-linked immunoabsorbant assay (ELISA).
2.E.03.04 Perform western blotting.
2.E.03.05 Perform DNA fingerprinting.
2.E.03.06 Perform Polymerase Chain Reaction (PCR).
2.E.03.07 Perform gram staining.
2.E.03.08 Determine protein concentration.
2.E.03.09 Determine enzyme activity.

2.E.03 Performance Example:
- Isolate plasmid DNA from transformed bacteria and determine DNA concentration and purity using a spectrophotometer set to absorbance 260 nm for concentration and a 260/280 nm ratio to determine purity.
- Separate Bovine Serum Albumin (BSA) from a mixture of proteins using SDS polyacrylamide gel electrophoresis (SDS PAGE).

2.E.04 Perform separation techniques.
2.E.04.01 Operate centrifuges.
2.E.04.02 Use filtration devices and systems.
2.E.04.03 Use electrophoresis systems (e.g., SDS PAGE and agarose gel electrophoresis).
2.E.04.04 Use chromatography (e.g., size exclusion, affinity, HIC, ion exchange).

2.E.04.05 Compare and contrast various chromatography methods. (including size exclusion, HPLC, reverse phase, affinity, HIC, ion exchange, etc.).

2.E.04 Performance Example:
- Assemble and pour size exclusion columns of various column bed depths.
- Compare and contrast various separation techniques.

2.F Cell techniques

2.F.01 Perform aseptic technique.

2.F.01.01 Decontaminate work area prior to and after use.
2.F.01.02 Dispose of waste following appropriate decontamination procedures.
2.F.01.03 Maintain a sterile environment using a biological safety cabinet.
2.F.01.04 Operate an autoclave and explain its use in sterile technique.
2.F.01.05 Sterilize reagents, solutions, and media properly according to established procedures.

2.F.01 Performance Example:
- Students will decontaminate the biological safety cabinet prior to use.
- Students will autoclave prepared media.
- Students will filter sterilize heat–labile solutions.

2.F.02 Maintain microorganisms.

2.F.02.01 Establish clonal cultures from a colony isolation.
2.F.02.02 Culture bacteria using nutrient media on sterile agar plates and in fermentation flasks and test tubes.
2.F.02.03 Identify bacteria using staining techniques, growth on selective media, and DNA analysis.

2.F.02 Performance Example:
- Isolate a single colony from a plate and streak for isolation on another plate.
- Prepare a slide from an isolated bacterial colony and perform a gram stain to determine if the bacteria are Gram negative or positive.

2.F.03 Transform cells.

2.F.03.01 Transform bacteria with a plasmid.
2.F.03.02 Explain transformation protocols for plant, mammalian and other cells.

2.F.03 Performance Example:
- Transform Eschericia coli JM109 with a plasmid containing a gene that codes for kanamycin resistance. Plate on LB agar plates containing kanamycin.
- Write a paper (or prepare a PowerPoint) that describes techniques for transformation of plant, bacterial and mammalian cells.

2.F.04 Maintain animal cells in tissue culture.

2.F.04.01 Maintain suspension and/or attached cells.
2.F.04.02 Preserve cells using cryopreservation.

2.F.04 Performance Example:
- Students will prepare media for growing animal cells.
- Students will grow and maintain cells (contamination free) in culture and passage those cells as necessary.

2.F.05 Clone plants.

- 2.F.05.01 Prepare and sterilize explants containing meristematic tissues.
- 2.F.05.02 Place explants in appropriate growth agar.
- 2.F.05.03 Monitor daily and record amount of time to callus, shoot, root and leaf formation; document stages of development photographically.
- 2.F.05.04 Transfer to new media, if appropriate.
- 2.F.05.05 Transfer the plantlet to solid potting mixture when it is large enough.

2.F.05 Performance Example:

- Cut a young leaf off an African violet plant. Sterilize the leaf by serial passage through 70% ethanol, then bleach solutions and then rinse in sterile water. Excise a piece of leaf, 0.5 cm square, that includes a portion of the vein.
- Insert the explant in sterile, shoot elongation agar such that a cut edge is wedged approximately ¼ of the way into the media.

2.F.06 Use inverted microscopes to view cell cultures.

2.F.06 Performance Example:

- Use an inverted microscope to view attached and suspension tissue culture cells.
- Use an inverted microscope to count cells on a hemocytometer.

2.F.07 Determine the viability of cells in culture.

2.F.07 Performance Example:

- Treat cells with trypan blue and count live and dead cells on a hemocytometer. If cells take up the trypan blue, they are non-viable.. Determine the % of dead cells..
- Treat attached cells on a plate with trypan blue and locate non-viable areas.

2.F.08 Describe the use of cells in biotechnology (e.g., use of cells in cancer research, as factories to produce enzymes and drugs, and for regenerative medicine therapies).

2.F.08 Performance Example:

- Explain the differences between the use of bacteria and mammalian cells to produce recombinant proteins.
- Explain the use of skin grafts in burn victims.

Strand 2: Technical Knowledge and Skills

2.A Drafting Safety Knowledge and Skills

2.A.01 Demonstrate an understanding of the importance of wearing safety glasses in setting where hazards are present and on outside job sites.

2.A.02 Identify and apply good ergonomic practices as they apply to the work of Drafters, both in shop settings and on outside projects.

2.B Fundamental of Drafting and Design

2.B.01 Apply general drafting standards.

- 2.B.01.01 Identify drawing media and related drafting materials.
- 2.B.01.02 Annotate a drawing by using basic systems of measurement.
- 2.B.01.03 Convert between English and metric systems (ISO) of measurement.
- 2.B.01.04 Identify the alphabet of lines.
- 2.B.01.05 Prepare title blocks and other drafting formats.
- 2.B.01.06 Catalog and use number system for documentation and file management.
- 2.B.01.07 Demonstrate methods used to record revisions.
- 2.B.01.08 Produce prints, plots and reproductions to appropriate scale.

2.B.01 Performance Example:

- Create a drawing using appropriate format and size. Include proper linetypes, revision, notes, etc. Produce a print to appropriate scale.

2.B.02 Develop views.

- 2.B.02.01 Create orthographic views.
- 2.B.02.02 Create auxiliary views.
- 2.B.02.03 Create section views.
- 2.B.02.04 Create detail views.
- 2.B.02.05 Create isometric views.
- 2.B.02.06 Place views considering first and third angle projection.
- 2.B.02.07 Identify 1, 2, and 3 point perspectives.

2.B.02 Performance Example:

- Given an object, develop a drawing that requires the use of each of the views listed.

2.B.03 Apply the design process.

- 2.B.03.01 Evaluate a problem and develop a solution using the design process.
- 2.B.03.02 Interpret detail prints or technical processes.
- 2.B.03.03 Identify key elements that impact design.

2.B.03 Performance Example:

- Given a product, apply the design process to develop new or revised product. Include documentation for each step of process.

2.C Conventional Drafting Techniques and Skills

2.C.01 Create free-hand technical sketches.

- 2.C.01.01 Letter using block style.
- 2.C.01.02 Sketch basic concept and/or object proportionately.
- 2.C.01.03 Make a sketch including detailed measurements/annotations.
- 2.C.01.04 Sketch a basic object based on “customer” needs.

2.C.01 Performance Example:

- Given an object, sketch appropriate views in proportion with annotations.

2.C.02 Apply dimensioning.
- 2.C.02.01 Apply correct dimension line terminators.
- 2.C.02.02 Apply size and location dimension practices.
- 2.C.02.03 Apply the use of dimensioning types (ordinate, leader, baseline/datum, chain, tabular).
- 2.C.02.04 Identify appropriate standard symbols.
- 2.C.02.05 Apply aligned and unidirectional methods.
- 2.C.02.06 Apply general notes and/or annotations to a drawing.

2.C.02 Performance Example:
- Using an existing drawing, apply appropriate dimensioning standards.

2.C.03 Measure, using the tools, knowledge and skills essential to drafting professionals.
- 2.C.03.01 Identify different measurement tools and their applications.
- 2.C.03.02 Measure parts using engineering, architectural, civil engineering, fractional, metric, and decimal inch scales.
- 2.C.03.03 Measure parts using vernier caliper and micrometer.
- 2.C.03.04 Develop drawings utilizing measurements.

2.C.03 Performance Example:
- Create an as-built drawing based on actual measurements taken.

2.D Computer Aided Drafting and Design

2.D.01 Create CAD template.
- 2.D.01.01 Set up layers/levels.
- 2.D.01.02 Set up dimension types (units/precision/scale/style/etc.).

2.D.01 Performance Example:
- Set parameters for a new drawing based on project requirements.

2.D.02 Produce CAD drawing.
- 2.D.02.01 Edit CAD drawing.
- 2.D.02.02 Manipulate CAD drawing.
- 2.D.02.03 Extract CAD data (mass/volume/area/etc.).
- 2.D.02.04 Create 3D models.
- 2.D.02.05 Create translatable files (pdf, dxf, stl, iges, step, etc.).

2.D.02 Performance Example:
- Modify or create model based on requirements, record CAD data and create output file.

2.E Mechanical Drafting and Design

2.E.01 Develop sheet metal patterns.
- 2.E.01.01 Identify sheet metal terminology and gauges.
- 2.E.01.02 Develop basic shapes using radial line and parallel line development.
- 2.E.01.03 Develop a flat pattern for precision bending.

2.E.01 Performance Example:
- Using a discarded product such as a milk carton or shoe box, create a full size pattern drawing.

2.E.02 Detail and Dimension Weldment.
- 2.E.02.01 Identify welding processes.
- 2.E.02.02 Identify various types of welded joints.
- 2.E.02.03 Apply welding symbols to a drawing.

2.E.02 Performance Example:
- Convert a cast part to a weldment using various symbols and processes.

2.E.03 Identify manufacturing processes.

2.E.03.01 Identify casting, forging, molding, extruding, machining, metal fabrication, and welding, etc. procedures.

2.E.03 Performance Example:
- Students create a presentation and assessment questions on one or more processes.

2.E.04 Produce mechanical drawings.

2.E.04.01 Draw detail drawings.

2.E.04.02 Draw assembly drawings.

2.E.04.03 Draw layout drawings.

2.E.04.04 Incorporate appropriate specification details using resources (standard/purchased items, machinery's handbooks, ASTM and ANSI standards, etc.).

2.E.04.05 Apply dual dimensioning for product and/or manufacturing drafting needs.

2.E.04 Performance Example:
- Create a layout, detail and assembly drawing for a simple product (pen, depth gauge, etc.)

2.E.05 Apply tolerances.

2.E.05.01 Identify tolerancing terminology.

2.E.05.02 Dimension with a consideration for tolerance stack-ups.

2.E.05.03 Calculate clearance and interference fit tolerance of mating parts using tables (RC, LN, FN, LT, LC).

2.E.05.04 Apply tolerance to dimensions using unilateral, bilateral and limits.

2.E.05.05 Apply geometric tolerance symbols.

2.E.05.06 Determine location of datum symbols.

2.E.05.07 Identify and apply surface (finish) control to part surfaces.

2.E.05 Performance Example:
- Create detail and assembly drawing with consideration of mating part fit.

2.E.06 Differentiate mechanical components.

2.E.06.01 Identify breaks, joints, couplings, bearings, clutches, belts, chains, gears, cams, etc.

2.E.06.02 Identify different types of fasteners (e.g., screws, nuts, rivets, springs, keys, pins, washers, etc.).

2.E.06.03 Specify thread nomenclature, series, classifications, and fits and forms.

2.E.06 Performance Example:
- Students create a presentation and assessment questions on one or more components.

2.E.07 Identify electro-mechanical drawings.

2.E.07.01 Identify basic electric/electronic components and symbols used in drafting.

2.E.07.02 Identify a schematic, wiring diagram, circuit diagram, and cable/harness drawings.

2.E.07 Performance Example:
- Interpret an existing diagram identifying appropriate symbols.

2.F Architectural Drafting and Design

2.F.01 Identify building types.

2.F.01.01 Distinguish between commercial, residential, and industrial construction.

2.F.01.02 Recognize the architectural styles of buildings.

2.F.01 Performance Example: ▪ Students create a presentation and assessment questions on building types and styles.

2.F.02 Draw construction drawings.

- 2.F.02.01 Select appropriate references (building codes, ADA, Architectural Graphic Standards, etc.).
- 2.F.02.02 Draw a plot plan considering civil engineering principles.
- 2.F.02.03 Draw floor plans (considering appropriate room planning: service, sleeping, and living areas).
- 2.F.02.04 Draw foundation plan (footings, etc.).
- 2.F.02.05 Draw interior/exterior elevations.
- 2.F.02.06 Draw sections.
- 2.F.02.07 Draw details (framing, window, door, etc.).
- 2.F.02.08 Draw roof plan.
- 2.F.02.09 Incorporate door, window and finish schedules.
- 2.F.02.10 Interpret electrical, plumbing, fireplace, exhaust, and HVAC drawings.
- 2.F.02.11 Calculate, develop, and layout stairs.
- 2.F.02.12 Create a set of the above drawings listed as they apply to one building / residence.
- 2.F.02.13 List common construction material sizes/lengths and describe how these constraints should be considered in design.

2.F.02 Performance Example: ▪ Produce plans for a simple single-story residence.

2.G Sustainability

2.G.01 Recognize Green Design.

- 2.G.01.01 Identify product design requirements.
- 2.G.01.02 Identify architectural design requirements (e.g., (LEED) Leadership in Energy and Environmental Design).

Third Year Drafting

Listed below are additional Categories of Learning, Standards and Objectives beyond the scope of the two year DESE requirement. They are placed in Supplemental Activities and can be used in the third year of a Drafting and Design Technology program.

2.H* ARCHITECTURAL DRAFTING AND DESIGN – *Supplemental Activities*

2.H.01* Calculate dead, live, snow and wind loads on the designed residential house.

- 2.H.01.01* Determine the tributary area of structural elements on the designed residential house.
- 2.H.01.02* Trace loads through the building to the foundation.

2.H.02* Redesign a parking lot.

- 2.H.02.01* Survey an existing parking lot.
- 2.H.02.02* Redesign the parking lot for maximum usage.
- 2.H.02.03* Estimate the cost of the redesign of the parking lot.

2.H.03* Determine the heat loss of the designed residential house.

2.H.04* Identify elements of civil design.

2.H.04.01* Describe materials and properties used in civil design.
2.H.04.02* Identify common civil symbols.
2.H.04.03* Identify zoning, environmental, and other regulations and guidelines that impact development.
2.H.04.04* Identify surveying instruments.
2.H.04.05* Plot using bearings, distances, and coordinates.
2.H.04.06* Place utilities, accesses, and contours within size and specifications as described in code.
2.H.04.07* Determine acreage.

2.I* COMPUTER AIDED DRAFTING AND DESIGN – *Supplemental Activities*

2.I.01* Set up CAD drawing format

Strand 2: Technical Knowledge and Skills

2.A Safety in the Electronics Laboratory

2.A.01 Demonstrate safe practices within the electronics laboratory following OSHA regulations, industry standards and established shop safety procedures.

- 2.A.01.01 Complete the requirements of OSHA 10-hour certification course and receive a course completion card.
- 2.A.01.02 Follow safety and emergency procedures, as defined in the shop safety manual.
- 2.A.01.03 Practice work habits that provide personal safety, safety for others, and protect the safety and security of the external environment.
- 2.A.01.04 Select and use appropriate personal protective equipment at all times.
- 2.A.01.05 Maintain a sanitary and clutter-free work environment.
- 2.A.01.06 Monitor, use, store, and dispose of materials according to established OSHA procedures.
- 2.A.01.07 Follow standard Electrostatic Discharge (ESD) procedures.

2.A.01 Performance Example:

- Student will complete the General Industry OSHA 10 hour training course.
- The student will prepare a shop Health and Safety plan describing safety procedures and work habits.

2.B Fundamentals of Electronic Circuit Assembly

2.B.01 Identify electronic schematic symbols.

- 2.B.01.01 Identify passive component symbols.
- 2.B.01.02 Identify active component symbols.
- 2.B.01.03 Identify and list variable component symbols.

2.B.01 Performance Example:

- Given a schematic of a variable output power supply; the student will identify resistors, capacitors, transformers, diodes, regulator ICs, potentiometers etc.

2.B.02 Draw a schematic diagram.

- 2.B.02.01 Sketch a basic circuit by hand.
- 2.B.02.02 Create a basic circuit using schematic software.

2.B.02 Performance Example:

- Using an electronic symbol template; the student will draw the schematic of a variable output power supply.

2.B.03 Produce a parts list.

- 2.B.03.01 List parts from a schematic.
- 2.B.03.02 Locate vendors for electronic parts.
- 2.B.03.03 Calculate total parts list cost.

2.B.03 Performance Example:

- Given a schematic of a variable output power supply; the student will generate a parts list including vendor and cost analysis.

2.B.04 Construct an electronic circuit prototype according to current industry and OSHA standards.

- 2.B.04.01 Describe the connections on a solder-less breadboard.
- 2.B.04.02 Arrange components on a solder-less breadboard.

2.B.04 Performance Example:
- Given a solder-less breadboard; the student will draw a line diagram showing which points are connected to each other.
- Given a solder-less breadboard, schematic, and all required parts; the student will build a functional variable output power supply prototype.

2.B.05 Assemble an electronic circuit on a printed circuit board.

2.B.05.01 Use solder to connect leaded components on a printed circuit board.
2.B.05.02 Use solder to connect surface mount components on a printed circuit board.
2.B.05.03 Differentiate polarity markings on components.

2.B.05 Performance Example:
- Given an unpopulated printed circuit board and all required parts; the student will assemble a variable output power supply.

2.C Theory and Application of DC

2.C.01 Apply electronic circuit laws.

2.C.01.01 Use Ohm's Law to calculate voltage.
2.C.01.02 Use Ohm's Law to calculate current.
2.C.01.03 Use Ohm's Law to calculate resistance.
2.C.01.04 Use Watt's law to calculate power.
2.C.01.05 Use Kirchhoff's law to verify total voltage and total current.
2.C.01.06 Describe basic magnetism laws and principles.

2.C.01 Performance Example:
- Given a series-parallel resistive network schematic; the student will calculate total current, individual voltage drops, parallel current legs, and power values.
- Given two separate coils of wire; the student will demonstrate how the coils are repelled or attracted to each other when power is applied and polarity is reversed.

2.C.02 Apply electronic circuit theorems.

2.C.02.01 Use Norton's theorem to analyze DC circuits.
2.C.02.02 Use Thevenin's theorem to analyze DC circuits.
2.C.02.03 Use Superposition to analyze DC circuits.

2.C.02 Performance Example:
- Given a series-parallel resistive network schematic; the student will calculate the Thevenin's voltage and resistance values.

2.C.03 Construct and test DC circuits.

2.C.03.01 Construct a circuit and verify Thevenin's Theorem.
2.C.03.02 Construct a circuit and verify Norton's Theorem.

2.C.03 Performance Example:
- Given a series-parallel resistive network schematic; the student will measure total current, individual voltage drops and parallel current leg values.
- Given a series-parallel resistive network schematic; the student will measure the Thevenin's voltage and resistance values.

2.D Theory and Application of AC

2.D.01 Perform calculations in AC circuits.

- 2.D.01.01 Calculate RMS, peak, peak-to-peak, and average values of a sine wave.
- 2.D.01.02 Calculate frequency, time and duty cycle of a periodic waveform.
- 2.D.01.03 Calculate phase shift.
- 2.D.01.04 Calculate reactance.
- 2.D.01.05 Calculate impedance.
- 2.D.01.06 Calculate apparent, true, reactive, power factor.
- 2.D.01.07 Calculate transformer characteristics.
- 2.D.01.08 Calculate filter circuits parameters.

2.D.01 Performance Example:

- Given a resistor-capacitor network schematic; the student will calculate capacitive reactance, impedance, and phase angle at three different input frequency values.

2.D.02 Perform measurements in AC circuits.

- 2.D.02.01 Measure peak and peak-to-peak values of a sine wave.
- 2.D.02.02 Measure frequency, time and duty cycle of a periodic waveform.
- 2.D.02.03 Measure phase shift.
- 2.D.02.04 Graphically plot reactance versus frequency.
- 2.D.02.05 Graphically plot impedance versus frequency.

2.D.02 Performance Example:

- Using an oscilloscope; the student will analyze a resistor-capacitor network including measuring AC input values (frequency, peak voltage etc) as well as component voltage drops, and phase shifts at three different input frequency values.
- Using a function generator and oscilloscope; the student will display a sine wave with a period of 13 microseconds.

2.E Theory and Application of Analog Electronics

2.E.01 Analyze semiconductors.

- 2.E.01.01 Explain manufacturers' specifications of semiconductor devices.
- 2.E.01.02 Explain characteristics of discrete semiconductors.
- 2.E.01.03 Explain biasing of discrete semiconductor devices.
- 2.E.01.04 Describe thermal management of discrete semiconductor devices.
- 2.E.01.05 Identify transistor configurations.
- 2.E.01.06 Identify and list types of transistor biasing configurations.
- 2.E.01.07 Identify rectifier diode circuits.
- 2.E.01.08 Identify regulator diode circuits.
- 2.E.01.09 Analyze power supply circuits.
- 2.E.01.10 Analyze a thyristor circuit.

2.E.01 Performance Example:

- Given selected diode and transistor circuit schematics; the student will calculate diode currents, BJT and FET transistor current and voltage values, and plot results on graph paper.
- Given a schematic of a power supply with a crowbar protection circuit; the student will specify the function and purpose of all semi-conductor devices.
- Given the required components; the student will demonstrate use of a BJT as a switch in saturation and cutoff.

2.E.02 Test semiconductors.

- 2.E.02.01 Test diodes with multimeters.
- 2.E.02.02 Test transistors.

2.E.02.03 Test thyristors.

2.E.02 Performance Example:
- Using a multi-meter; the student will measure and record forward and reverse bias resistance values of various diodes, BJT and FET transistors, and an SCR.

2.E.03 Construct and test semiconductor circuits.
- 2.E.03.01 Measure and explain current and voltage characteristics of diode types.
- 2.E.03.02 Measure and explain current and voltage characteristics of transistor types.
- 2.E.03.03 Measure and explain current voltage characteristics of thyristor types.
- 2.E.03.04 Analyze transistor amplifiers circuits.
- 2.E.03.05 Analyze oscillator circuits.

2.E.03 Performance Example:
- Given selected diode and transistor DC circuit schematics, solder-less breadboard, and required components; the student will measure diode currents, BJT and FET transistor current and voltage values, and prepare laboratory reports on the collected data.
- Given selected transistor amplifier circuit schematics, solder-less breadboard, and required components; the student will measure BJT and FET transistor voltage gain values, phase relationships, and prepare laboratory reports on the collected data.
- Given the required parts; the student will build a 30 kHz oscillator using a 555 timer.

2.E.04 Evaluate operational amplifier circuits.
- 2.E.04.01 Describe operational amplifier IC characteristics.
- 2.E.04.02 Design operational amplifier circuits.

2.E.04 Performance Example:
- Given various operational amplifier circuit schematics; the student will calculate input-output current and voltage values, and prepare laboratory reports on the collected data.
- Given various operational amplifier circuit schematics, solder-less breadboard, and required components; the student will measure input-output current and voltage values, and prepare laboratory reports on the collected data.

2.F Theory and Application of Digital Electronics

2.F.01 Perform calculations in digital circuits.
- 2.F.01.01 Use the two's complement number system for math operations.
- 2.F.01.02 Convert between binary, decimal and hexadecimal numbers.
- 2.F.01.03 Identify and use alternate digital codes.
- 2.F.01.04 Draw logic diagrams from Boolean expressions.
- 2.F.01.05 Write truth table from a Boolean expression or logic circuit.
- 2.F.01.06 Use reduction theorems to simplify digital electronic circuits.
- 2.F.01.07 Analyze waveforms for latches/flip-flops.
- 2.F.01.08 Analyze counter circuits waveforms.

2.F.01 Performance Example:
- Given appropriate worksheets; the student will convert between binary, octal, decimal, and hexadecimal numbering systems.
- Using K-Mapping and Boolean algebra; the student will simplify SOP expressions.
- Given appropriate worksheets; the student will convert between Boolean expressions, truth tables and logic diagrams.

2.F.02 Identify and apply digital principles.
- 2.F.02.01 Differentiate between high, low and tri-state characteristics of a digital signal.

2.F.02.02 Identify basic TTL gates of the 7400 series and describe IO characteristics.
2.F.02.03 Specify pin numbers and manufacturer markings on digital ICs.
2.F.02.04 Compare and contrast the differences between TTL and CMOS logic families.
2.F.02.05 Identify and calculate parity bits for error control.
2.F.02.06 Describe the universal properties of NAND and NOR gates.
2.F.02.07 Illustrate alternate schematic forms of basic logic gates.
2.F.02.08 Identify various combinational and sequential logic circuits.
2.F.02.09 List reduction theorems used to simplify digital Electronic circuits.
2.F.02.10 Identify the basic architecture of a microprocessor or microcontroller.
2.F.02.11 Describe a digital oscillator circuit.
2.F.02.12 Describe circuits that perform A/D and D/A conversions.

2.F.02 Performance Example:
- Given circuit schematic, solder-less breadboard, and required components; the student will use a counter IC to drive a 3 to 8 decoder.
- Given circuit schematic, solder-less breadboard, and required components; the student will build a 2 bit Adder circuit using NAND gates.

2.F.03 Identify and describe characteristics of digital components.
2.F.03.01 Define and describe PLDs (Programmable Logic Devices).
2.F.03.02 Describe line driver characteristics and their applications.

2.F.03 Performance Example:
- Given circuit schematic, solder-less breadboard, and required components; the student will connect multiple tri-state line driver devices (such as 74244 or equivalent) to a common bus and use the tri-state controls to determine which device drives the bus.

2.F.04 Construct and test digital circuits.
2.F.04.01 Wire, test and explain combinational logic circuits.
2.F.04.02 Wire and test various flip-flops to verify truth tables.
2.F.04.03 Wire and test various latches to verify truth tables.
2.F.04.04 Measure waveforms for counter circuits and analyze behaviors and characteristics.
2.F.04.05 Construct, simulate and explain encode and decode circuits.
2.F.04.06 Construct, simulate and explain shift registers.
2.F.04.07 Construct, simulate and explain comparators.
2.F.04.08 Construct, simulate and explain adder circuits.
2.F.04.09 Construct, simulate and explain multiplexer ICs.

2.F.04 Performance Example:
- Given circuit schematic, solder-less breadboard, and required components; the student will use a flip-flop and combinatorial logic to turn on an LED when an 8 bit counter reaches a specified value.

2.G Applied Engineering

2.G.01 Utilize engineering concepts.
2.G.01.01 List and apply the steps of the design process to designated electronics projects.
2.G.01.02 Utilize the steps of the design process to solve given problems.
2.G.01.03 Work in teams using brainstorming techniques to create new designs.
2.G.01.04 Use engineering notations and prefixes.
2.G.01.05 Describe and use the steps for troubleshooting a given problem.

2.G.01 Performance Example:
- The student will develop both analog and digital versions of a collision detection and drive control system. Compare the positive and negative features of the two approaches.
- Given appropriate worksheets; the student will convert between kilo, mega, milli, micro, nano, and pico numeric representations..

2.G.02 Develop engineering documents.
- 2.G.02.01 Write a technical design report.
- 2.G.02.02 Maintain engineering logs/journals for projects.
- 2.G.02.03 Utilize a variety of media formats to convey designs and processes.

2.G.02 Performance Example:
- The student will save a schematic from a schematic capture system and convert the file so it can be imported to an MS-Word document.

2.G.03 Examine motors.
- 2.G.03.01 Identify the various types of electric motors and demonstrate their proper use/operation.
- 2.G.03.02 Identify various types of stepper motors.
- 2.G.03.03 Utilize stepper motor circuitry.
- 2.G.03.04 Design, build and operate a simple electric motor.

2.G.03 Performance Example:
- Given circuit schematic, solder-less breadboard, and required components; the student will examine the relationships between voltage level and polarity and a DC motor speed and rotation direction.
- Use a stepper motor control system to steer a vehicle in a prescribed path.
- Build a simple DC motor using a coil of wire, a magnet, and a power source.

2.G.04 Design an autonomous robotics system.
- 2.G.04.01 Utilize sensors to interface in a robotic control system.
- 2.G.04.02 Design, build, and operate an autonomous robot.

2.G.04 Performance Example:
- Given the required components; the student will program a robot to maneuver through an obstacle course.
- Design and build an autonomous vehicle that drives toward the brightest light in a room.
- Design a controller that turns 8 devices on and off in sequence for various prescribed time periods.

2.H Software Applications

2.H.01 Utilize programming.
- 2.H.01.01 Write a simple control program using a programming language.
- 2.H.01.02 Simulate a circuit using a software simulation program.

2.H.01 Performance Example:
- Write a software program to turn one of eight LEDs on in repeating sequential order.

2.H.02 Design circuit layouts.
- 2.H.02.01 Use PCB software to develop a basic circuit design.
- 2.H.02.02 Describe or use a process for PCB fabrication.

2.H.02 Performance Example:
- Simulate the performance of a modulo 9 digital counter circuit in your schematic capture software system.
- Using printed circuit board software; the student will generate a milling file for an electronic circuit board.

2.I Applied Electronic Devices in a Manufacturing Environment

2.I.01 Utilize electronic equipment for measuring.
- 2.I.01.01 Identify DC functions and ranges on measuring devices.
- 2.I.01.02 Use a multimeter to measure DC circuit values.
- 2.I.01.03 Identify AC functions and ranges on measuring devices.
- 2.I.01.04 Use a multimeter to measure AC circuit values.
- 2.I.01.05 Demonstrate the use of an oscilloscope.
- 2.I.01.06 Demonstrate the use of a function generator.
- 2.I.01.07 Identify various waveforms.

2.I.01 Performance Example:
- Given the required components; the student will demonstrate how to use a meter to measure DC and AC voltage.
- Given the required components; the student will demonstrate how to use an oscilloscope to measure DC and AC voltage.

2.I.02 Utilize tools to build electronic projects.
- 2.I.02.01 Solder and crimp connectors and lugs.
- 2.I.02.02 Solder and de-solder electronic components, including surface mount components.
- 2.I.02.03 Select and use basic hand tools and equipment used for electronic circuits.
- 2.I.02.04 Describe and use advanced hand tools and equipment designed for manufacturing of electronic devices.

2.I.02 Performance Example:
- Given an electronic circuit kit: the student will construct a working electronic device from a kit.

2.J Advanced Standards (ETA Sourced)

2.J.01* Demonstrate knowledge and skills relevant to computer electronics.
- 2.J.01.01* Describe the major sections of a computer.
- 2.J.01.02* Demonstrate how the computer block diagram and flow charts are utilized.
- 2.J.01.03* Describe different types of computer memory and how storage is accomplished.
- 2.J.01.04* Explain the importance of an Arithmetic Logic Unit (ALU).
- 2.J.01.05* Define ROM, RAM, PROM, EPROM, EEPROM and EAPROM.
- 2.J.01.06* Explain the importance of data-buses and their associated bandwidth.
- 2.J.01.07* Explain the reasons for different computer languages and their relationships.
- 2.J.01.08* Define the words ‘peripheral device’ and list various types.
- 2.J.01.09* Explain the reasons for using interface devices/chips/cards and name common types.

2.J.02* Demonstrate knowledge and skills relevant to optical electronics.
- 2.J.02.01* List common electronics display devices.
- 2.J.02.02* Explain how LCD displays operate, comparing their advantages and disadvantages.
- 2.J.02.03* Describe how LED remote hand units work.
- 2.J.02.04* Explain why and list some locations of circuits in which opto-isolators are used.
- 2.J.02.05* List uses of light activated controls and explain how photo devices are incorporated.

2.J.03* Demonstrate knowledge and skills relevant to audio and video Systems.
- 2.J.03.01* Explain the major components of the most common home entertainment products.
- 2.J.03.02* Describe microphone technology and usage.
- 2.J.03.03* Explain speaker construction and precautions.
- 2.J.03.04* Compare the differences between good quality and distorted sound and describe the electronic/acoustical reasons for each.
- 2.J.03.05* Explain how signals may conflict and the symptoms the conflict may produce.
- 2.J.03.06* Explain how to isolate troubles between discrete equipment units.

2.J.04* Demonstrate knowledge and skills relevant to communications electronics.
- 2.J.04.01* Describe major types of two-way radio communications (e.g., avionics, land mobile and maritime).

2.J.06 Apply the principles of interior landscape design.

- 2.J.06.01 Use scientific names to identify the most common indoor plants using the National FFA Floriculture Career Development Event Plant List.
- 2.J.06.02 Practice effective plant use in the interior landscape (e.g., light, water and temperature requirements and size).
- 2.J.06.03 Identify the functions of plants used in interior locations.
- 2.J.06.04 Plan and implement an interior plantscape while applying the principles of design.
- 2.J.06.05 Evaluate the elements of a design. (e.g., screens, living walls, accent pieces, etc.) and analyze their usage.
- 2.J.06.06 Identify the special care required for tropical & foliage plants.
- 2.J.06.07 Develop a maintenance schedule for interior plantscapes.
- 2.J.06.08 Select and decorate the appropriate indoor plant for a specific use and distinguish between permanent and temporary indoor plants.

2.J.06 Performance Example:

- Create a reference guide depicting light and water requirements for plants used in interior spaces.

2.K Greenhouse Management & Production

2.K.01 Describe the types of basic greenhouse structures & systems.

- 2.K.01.01 Compare and contrast the various types of greenhouse structures and their construction including Gothic arch, Quonset, ridge and furrow and uneven-span and identify the attributes of each.
- 2.K.01.02 Identify the construction materials used to build greenhouses and compare the various forms of greenhouse coverings (e.g., polyethylene, glass, etc.).
- 2.K.01.03 Identify the uses of coldframes, hotbeds, growing rooms and bulb cellars.
- 2.K.01.04 Compare shade materials and methods.
- 2.K.01.05 Calculate the heat requirements for a greenhouse and compare and contrast the commonly used heating systems.
- 2.K.01.06 Summarize the benefits of ventilation and cooling and identify methods of both.
- 2.K.01.07 Differentiate between the various types of greenhouse benches and arrangements.
- 2.K.01.08 Calculate the bench space required dependent on a variety of pot sizes, spacing and arrangements.

2.K.01 Performance Example:

- Design a greenhouse structure, determining the requirements for covering, heating, irrigation and bench arrangement.

2.K.02 Assess the use of different growing media's and fertilizers in greenhouse production.

- 2.K.02.01 Evaluate the makeup of varying types of growing media used in the greenhouse.
- 2.K.02.02 Identify the uses for artificial or soilless media.
- 2.K.02.03 Summarize fertilizer requirements of a variety of crops and how it changes throughout the life of the plant.
- 2.K.02.04 Identify the forms of fertilizers which can be applied (e.g., dry, liquid, control released) and describe the appropriate uses for each.
- 2.K.02.05 Monitor salt levels in media and identify the impacts of salt and poor drainage on a plant's health.

2.K.02.06 Calculate fertilizer application rates (direct injector proportions and traditional application methods).
2.K.02.07 Evaluate methods and chemicals needed to change water quality.
2.K.02.08 Calculate the amount media required to fill a variety of pot sizes for production.

2.K.02 Performance Example:
- Create a balanced fertilizer program for a greenhouse crop and calculate the amount of fertilizer necessary to complete the program.

2.K.03 Explain the role of water in greenhouse production.
2.K.03.01 Identify the types of manual and automatic watering systems commonly found in greenhouses.
2.K.03.02 Compare and contrast watering methods such as hose watering, intermittent mist system, overhead water, perimeter irrigation, soaker hose system and tube irrigation. Identify the advantages of each.
2.K.03.03 Compare capillary mats and ebb and flood benches to other irrigation methods.

2.K.03 Performance Example:
- Create two irrigation systems for the school's greenhouse and identify the advantages and disadvantages of each.

2.K.04* Explain the role of hydroponics in the industry and apply production principles.
2.K.04.01* Describe the history, importance and use of hydroponics in the industry.
2.K.04.02* Evaluate and compare structures, growing media and methods used in hydroponic production facilities.
2.K.04.03* Identify crops that could be grown hydroponically.
2.K.04.04* Describe the nutritional requirements of hydroponic crops and how nutrients are obtained.
2.K.04.05* Calculate nutrient rate and volume measurements for hydroponic systems and the role that water plays in production.
2.K.04.06* Perform common tests on water for production.

2.K.04 Performance Example:
- Analyze root growth in different types of hydroponic growth medium.

2.K.05 Apply knowledge to the propagation and reproduction of plants.
2.K.05.01 Explain the environmental requirements for seed germination. (e.g., water, oxygen, temperature and light).
2.K.05.02 Describe the requirements of a germination media (e.g., components, texture, water capacity, and sterility).
2.K.05.03 Identify and select seed sowing methods appropriate for size of seed and production method.
2.K.05.04 Cite the requirements for transplanting seedlings (e.g., stage of growth and environmental requirements).
2.K.05.05 Differentiate between the types of cutting for asexual propagation (e.g., including stem, leaf and leaf bud cuttings).
2.K.05.06 Evaluate the environment required for cuttings (e.g., moisture, temperature, media, sterility, and fertilization).
2.K.05.07 Perform the layering and division method of propagation.

2.K.05.08* Explain the importance of plant biotechnology (e.g., micro propagation/tissue culture) in the industry and society and how it affects production and yields.
2.K.05.09* Compare and contrast meristem and tissue culture.
2.K.05.10* Describe the techniques and environmental conditions necessary to undertake the process of tissue culture.
2.K.05.11* Demonstrate the process of tissue culture using the appropriate methods and techniques.

2.K.05 Performance Examples:
- Perform the multiple types of asexual propagation and compare the rate of plant production.
- Chart the germination and development of seedlings.

2.K.06 Apply methods of controlling plant disease and pests in a greenhouse environment.
2.K.06.01 Distinguish between biological, cultural, physical and chemical pest management practices.
2.K.06.02 Identify the common insects found in greenhouse plants including aphids, mealybug, mites, thrip, and scale.
2.K.06.03 Identify commonly found diseases in greenhouse such as Botrytis blight, downy mildew, powdery mildew, *Pythium*, *Phytophthora*, *Rhizoctonia*, X*anthomonas*, and other bacteria and viruses.
2.K.06.04 Describe a greenhouse environment that discourages disease growth.

2.K.06 Performance Example:
- Develop a quick reference guide for common greenhouse pests and diseases, include potential remedies and treatments.

2.K.07 Identify and explain the principles for producing greenhouse crops.
2.K.07.01 Identify major greenhouse crops including, African violets, bedding plants, chrysanthemums, cineraria, cyclamen, Easter Lilies & other bulb plants, foliage plants, gloxinia, holiday cacti, kalanchoe, orchids, poinsettias and vegetables.
2.K.07.02 Transplant plants in various stages of growth.
2.K.07.03 Define photoperiodism and distinguish between short-day plants, long-day plant and day-neutral plants.
2.K.07.04 Describe lighting requirements in a greenhouse including supplemental lighting.
2.K.07.05 Analyze the impact of temperature on plant growth and development (e.g., DIF, thermoperiodism, etc.).
2.K.07.06 Utilize plant regulators and retardants to alter plant hormones effectiveness.
2.K.07.07 Compare and contrast methods of pinching and disbudding.
2.K.07.08 Summarize factors to consider when selecting a greenhouse crop to produce.
2.K.07.09 Explain the seasonal markets for greenhouse crops.

2.K.07 Performance Example:
- Prepare a planning production guide for a specific greenhouse crop taking into account, starting stock, lighting, temperature and desire target date.

2.L Floriculture Business Operations

2.L.01 Demonstrate the knowledge and skills required to operate a floriculture business.
2.L.01.01 Describe the various types of floral businesses in the industry.

2.L.01.02 Describe the logistics and planning of floral deliveries including events and sympathy.
2.L.01.03 Explain the role of wholesalers in the marketing and distribution of crops.
2.L.01.04 Compute the unit cost of goods sold.
2.L.01.05 Calculate the retail cost of goods using the Standard Ratio Markup, Retail Cost of Goods plus Labor, Divisional Percentage Pricing and Leader Pricing.
2.L.01.06 Package plants and designs for distribution or delivery.
2.L.01.07 Identify methods used to sell or fill floral orders outside a delivery zone.

2.L.01 Performance Example:
- Create a flow chart identifying the route of a specific floral product, and what it takes to arrive at a flower shop (Flower chain).

2.L.02* Develop marketing strategies pertaining to the floral industry.
2.L.02.01* Identify methods to merchandize floral products and services.
2.L.02.02* Distinguish between merchandizing and visual displays.
2.L.02.03* Identify the purposes and categories of visual displays.
2.L.02.04* Develop and illustrate visual merchandizing strategies.

2.L.02 Performance Example:
- Create a display featuring a floral product and illustrate an advertisement to accompany it.

NOTES:

* Indicates supplemental/advanced learning standards and objectives.

Horticulture Concentration: Landscaping and Turf Management

2.M Safety and Health Knowledge and Skills

2.M.01 Demonstrate safety and appropriate health precautions when working in adverse weather conditions.
2.M.01.01 Identify potential hazards related to sun exposure and UV rays.
2.M.01.02 Identify potential hazards related to summer heat conditions (e.g., heat stroke, heat exhaustion, dehydration).
2.M.01.03 Identify potential hazards related to extreme cold (e.g., hypothermia, frost bite, dehydration).
2.M.01.04 Identify potential hazards of storm weather (e.g., lightning, high winds, mixed precipitation, freezing surfaces).

2.M.01 Performance Examples:
- Perform various horticulture tasks in adverse weather conditions such as rain, snow, cold and heat using appropriate PPE and clothing.

2.M.02 Identify safety and health hazards when working in outdoor environments and demonstrate safe practices.
2.M.02.01 Identify and recognize the hazards, precautions, and symptoms of insect carrying diseases (e.g., Lyme Disease, EEE, malaria).
2.M.02.02 Identify and describe the hazards of animals (rabies, biting hazard).
2.M.02.03 Identify plants that may cause adverse reactions (e.g., poisonous plants, plant irritations, allergies).
2.M.02.04 Explain how OSHA's 4 High Hazard areas are responsible for the majority of serious workplace injuries and fatalities (e.g., Falls, Electrocutions, Struck By, and Caught Between).

Strand 2: Technical Knowledge and Skills

2.A Robotics and Automation Technology Safety Health and Skills

2.A.01 Obtain OSHA 10 Hour General Certification.

- 2.A.01.01 Implement safety knowledge obtained on a continuous basis.
- 2.A.01.02 Identify safety hazards in the shop, remove hazards and develop continuous improvement solutions.
- 2.A.01.03 Implement a tag-out and lock-out shop procedure.

2.A.01 Performance Example:

- Student will obtain an OSHA 10-hour general industry certificate.

2.A.02 Read and implement shop safety manual.

- 2.A.02.01 Demonstrate safety procedure(s) for maintaining machinery and equipment.
- 2.A.02.02 Demonstrate safety procedure(s) for operating machinery and equipment.

2.B Tools & Instrumentation

2.B.01 Demonstrate the use of tools, fasteners, and equipment.

- 2.B.01.01 Demonstrate and explain the use of threaded fasteners.
- 2.B.01.02 Demonstrate and explain the use of non-threaded fasteners.
- 2.B.01.03 Demonstrate and explain the use and types of anchors.
- 2.B.01.04 Install fasteners and anchors.
- 2.B.01.05 Demonstrate operation of power and power actuated tools according to current industry and OSHA standards and manufacturers' specifications.

2.B.01 Performance Example:

- Drill and tap at least 3 different size holes into a material and tap the holes using appropriate size tap. Use common size holes. (8-32, 10-32, ¼-20)

2.B.02 Use electrical test equipment.

- 2.B.02.01 Perform measurement of current using the ammeter / clamp-on.
- 2.B.02.02 Perform measurement of voltage using the voltmeter.
- 2.B.02.03 Perform measurement of resistance using the ohmmeter.
- 2.B.02.04 Measure circuit properties using the volt-ohm-multimeter (VOM).

2.B.02 Performance Example:

- Design a simple electrical circuit and measure ohms, volts and amperage using DVM.

2.B.03 Use electronic hand tools and equipment.

- 2.B.03.01 Identify and apply standard methods of attaching and making electrical connections; i.e. soldering, crimping, wire nuts and lugs.
- 2.B.03.02 Solder and de-solder electronic components.
- 2.B.03.03 Select and use basic hand tools and equipment used for electronic circuits including needle nose pliers, nut drivers, screwdrivers, wire cutters, wire strippers, and torque drivers.
- 2.B.03.04 Use advanced hand tools and equipment for assembling electronics circuits such as a Greenlee punch, taps and dies, hand drills, drill presses, and tools and riveters.

2.B.03 Performance Example:

- Design and build a simple electrical circuit consisting of stripped wires and soldered connections. Solder and de-solder and use all hand tools as needed.

2.B.04 Use measurement devices.

- 2.B.04.01 Identify and utilize both English and International (SI) measurement systems.
- 2.B.04.02 Define attributes, units, and systems of measurement used in Mechanical Engineering Technology (MET) fields.
- 2.B.04.03 Apply a variety of techniques, tools and formulas for determining measurements.
- 2.B.04.04 Identify appropriate electronic device/gauge for specific tasks.
- 2.B.04.05 Calibrate and use electronic devices and/or gauges accurately.

2.B.04 Performance Example:

- Measure a part using a 6 inch scale, micrometer and verniers.

2.C Engineering Design Process

2.C.01 Explain and demonstrate knowledge of the design process.

- 2.C.01.01 Identify the components of the design process.
- 2.C.01.02 Articulate the steps of the design process.
- 2.C.01.03 Use the design process to identify the problem(s) to be solved and evaluate the solutions to be tried.

2.C.01 Performance Example:

- Research different layout designs for the Design Process and explain the similarities and differences between them.
- Discuss and develop preliminary criteria that relate to the problem.

2.C.02 Create The Problem Statement.

- 2.C.02.01 Identify and define the problem in a written format.
- 2.C.02.02 Identify potential solutions through brainstorming.

2.C.02 Performance Example:

- Discuss and document as much as you can prior to doing research into a given problem.
- Write a Problem Statement to match the problem.

2.C.03 Research the related areas.

- 2.C.03.01 Identify the major areas to be researched.
- 2.C.03.02 Do background research into the problem.
- 2.C.03.03 Identify resources needed (supplies, personnel, equipment).

2.C.03 Performance Example:

- Determine the research needed, the process to be used, and then document the process and the finding from the research work done.
- Read and fully cite the relevant information that pertains to the problem.
- Present to peers a Problem Statement Review with background research represented and document the groups questions as additional research needed, i.e.: reiterative process.

2.C.04 Build and test a prototype; document the solution.

- 2.C.04.01 Develop solutions using a structured problem solving process.
- 2.C.04.02 Identify the components and process of the system.
- 2.C.04.03 Build a prototype or model.
- 2.C.04.04 Test product to verify that it meets customer specifications, regulations, etc.
- 2.C.04.05 Use appropriate testing equipment and tools for diagnosing the problem.
- 2.C.04.06 Document the solution; write a report.

2.C.04 Performance Example:
- Present a Design Review with all solutions represented to peers and document the group's questions for further consideration, i.e.: reiterative process.
- Develop and use a Decision Matrix based on relevant criteria to choose a final design solution.
- Present a Final Design Review with all background research represented and documented testing procedures and data to peers.

2.D Technical Communications

2.D.01 Develop working knowledge of various types of written technical communications.

2.D.01.01 Read and interpret technical reports, trade journals, machine manuals, Safety Protocols (SDS) and web sources.

2.D.01.02 Generate a technical report.

2.D.01 Performance Example:
- Write an abstract based on a technical document.
- Present a technical review based on a technical document.
- Participate in an on-line chat or a Blog site about a technical topic. Summarize your findings.

2.D.02 Demonstrate visual communications within the Electrical and Electronics fields.

2.D.02.01 Identify, read, and interpret electrical schematics and block diagrams.

2.D.02.02 Identify the schematic symbols and wiring diagrams for the major international standards: IEEE, International Organization for Standardization (ISO), American National Standards Institute (ANSI), etc.

2.D.02 Performance Example:
- Look-up and review different type of electrical & electronic schematics symbols and match them to the actual component.
- Research the different International Organizations that have different electrical and electronic symbols.

2.D.03 Demonstrate visual communications within the process control systems and/or programming.

2.D.03.01 Identify and interpret the standard flow charts symbols for the major international standards: IEEE, International Organization for Standardization (ISO), American National Standards Institute (ANSI), etc.

2.D.03.02 Read and interpret process control flow charts.

2.D.03.03 Identify and use appropriate symbols to develop a process diagram of a given process.

2.D.03 Performance Example:
- Research and report on the different International Organizations that have different flow chart symbols.
- Identify and follow a process using a flow chart for a given system.
- Develop a flow for an Automated Work Cell and use it to explain the job function(s).

2.D.04 Hand sketch drawings.

2.D.04.01 Define, and describe orthographic projections.

2.D.04.02 Produce fully annotated orthographic projections of a part.

2.D.04.03 Produce a free hand drawing of a mechanical component.

2.D.04.04 Produce sketches by integrating sketching techniques and styles.

2.D.04.05 Select and produce the appropriate pictorial style to best communicate solutions in the design process.

2.D.04 Performance Example:
- Generate orthographic hand sketches of different 3D object and fully denote all relevant dimensions
- Generate pictorial hand sketches of different 3D object to show part orientation.

2.D.05 Demonstrate basic use of a CAD system.

2.D.05.01 Create 2D-Orthographical drawings and pictorial drawings from CAD software.

2.D.05.02 Read and interpret detail blue prints or technical processes.

2.D.05.03 Define various geometric shapes and relationships and use appropriate geometry tools to draw basic shapes.

2.D.05.04 Distinguish among and define geometric constraints.

2.D.05.05 Identify and use the following geometric constraints in given three-dimensional models: horizontal, vertical, parallel, perpendicular, tangent, concentric, collinear, coincident, and equal.

2.D.05.06 Use the appropriate form of the Cartesian coordinate system to measure and plot a model.

2.D.05 Performance Example:
- Using a CAD design package, generate fully annotated orthographic drawing of different 3D object and show all relevant dimensions
- Using a CAD design package, generate pictorial drawing of different 3D object.
- Generate shop drawing to be used to produce the part.

2.E Mechanical Concepts

2.E.01 Design and build a mechanical transfer system.

2.E.01.01 Identify and describe all six simple machines (SM).

2.E.01.02 Develop working knowledge for the terms: Ideal Mechanical Advantage (IMA), Actual Mechanical Advantage (AMA), Power & Power Transfer, Efficiency, Compound Machine, Work In-put and Work Out-put.

2.E.01.03 Define each of the SM and give examples of their uses.

2.E.01.04 Build and demonstrate a SM.

2.E.01.05 Calculate the IMA & AMA for the different SM.

2.E.01.06 Design, build and operate a Compound Machine.

2.E.01.07 Identify the role that friction plays in SM operation.

2.E.01 Performance Example:
- Build a simple machine that turns rotary motion into linear motion.

2.E.02 Design and build a hydraulic system.

2.E.02.01 Identify and apply all safety protocols for hydraulic systems.

2.E.02.02 Identify the parts of a typical hydraulic cylinder and their designated uses.

2.E.02.03 Identify the various types of hydraulic pumps and their designated uses.

2.E.02.04 Identify the various types of hydraulic accumulators and their designated uses.

2.E.02.05 Identify the various types of actuators and their designated uses.

2.E.02.06 Identify the various types of hydraulic motors and their designated uses.

2.E.02.07 Identify the schematic symbol for each part of a hydraulic system.

2.E.02.08 Identify the operation of relief valves, pressure compensated flow control valves, check valves, directional control valves and servo control valves as used in a hydraulic system.

2.E.02.09 Design and build (or simulate) and operate a hydraulic system.

2.E.02 Performance Example:
- Design a simple hydraulic diagram for the operation of a dump truck bed.

2.E.03 Design and build a pneumatic system.
- 2.E.03.01 Identify and apply all safety protocols for pneumatic systems.
- 2.E.03.02 Identify the most commonly used components (including gases) used in a pneumatic system.
- 2.E.03.03 Identify the various types of compressors and their designated uses/operations.
- 2.E.03.04 Identify and describe the operation of desiccant dryers, receiver tanks, pressure switches and pressure regulators as used in a pneumatic system.
- 2.E.03.05 Identify the schematic symbols for compressors, safety release valves, single action spring return cylinders, after coolers, receivers, dryers, pilot regulators, slave regulators, exhaust center directional control valves, pressure center directional control valves, lubricators, filters and blocked center directional control valves as used in a pneumatic system.

2.E.03 Performance Example:
- Design and build a pneumatic system that can clamp a part using a single actuator controlled by a manual valve.

2.E.04 Identify and describe basic machine operations.
- 2.E.04.01 Identify and describe the use of a vertical mill.
- 2.E.04.02 Identify and describe the use of a lathe.
- 2.E.04.03 Identify and describe the use of power tools.

2.E.04 Performance Example:
- Explain how a machined part for a piece of equipment is made, show examples for milling and turning, and cutting.

2.F Electrical Concepts

2.F.01 Describe electrical current and electron theory.
- 2.F.01.01 Label the parts of an atom.
- 2.F.01.02 Explain the differences between an insulator and conductor.
- 2.F.01.03 Explain the difference between “Conventional Current Flow” and “Electron Flow” theories.
- 2.F.01.04 Describe the difference between direct and alternating current.
- 2.F.01.05 Describe the difference between analog and digital signals.

2.F.01 Performance Example:
- Explain the difference between
  - “Conventional and Electron “ Current Flow
  - AC and DC Electricity
  - Analog and Digital signals

2.F.02 Demonstrate knowledge of basic electronic components.
- 2.F.02.01 Identify switches and explain their functions (NO, NC, SPST, SPDT, DPST, DPDT, Multi-selector).
- 2.F.02.02 Identify and explain the function of resistors and potentiometers.
- 2.F.02.03 Identify resistors using the color code.
- 2.F.02.04 Identify and explain the function of capacitors.

2.F.02.05 Identify and explain the function of inductors and transformers.
2.F.02.06 Identify and explain the function of diodes.
2.F.02.07 Identify and explain the function of transistors (BJTs and FETs).
2.F.02.08 Identify and explain the function of LEDs and lamps.

2.F.02 Performance Example:
- Given a set of electronic components, identify each and briefly describe their function and application

2.F.03 Build, simulate and test basic electric circuits.
- 2.F.03.01 Construct a series circuit and investigate Ohm's Law.
- 2.F.03.02 In a series circuit, measure voltage and current at various points in the circuit.
- 2.F.03.03 In a series circuit, investigate Kirchoff's Voltage Law by measuring voltages.
- 2.F.03.04 Construct a parallel circuit and describe its relation to Ohm's Law.
- 2.F.03.05 In a parallel circuit, measure voltage and current at various points in the circuit.
- 2.F.03.06 In a parallel circuit, investigate Kirchoff's Current Law by measuring currents.
- 2.F.03.07 Construct a series-parallel circuit and describe its relation to Ohm's Law.
- 2.F.03.08 In a series-parallel circuit, measure voltage and current at various points in the circuit.
- 2.F.03.09 Calculate power dissipated using Watt's Law.
- 2.F.03.10 Identify and interpret relay wiring diagrams.
- 2.F.03.11 Identify and interpret ladder logic diagrams.

2.F.03 Performance Example:
- Given and electric circuit and measuring devices, determine voltage, current, resistance and power consumption at various points in the circuit

2.F.04 Test, use, and calculate magnetic devices.
- 2.F.04.01 Identify and explain magnetic principles and theorems.
- 2.F.04.02 Determine the effect of turns on an electromagnet.
- 2.F.04.03 Determine the effect of wire diameter on an electromagnet.
- 2.F.04.04 Determine the effect of current on an electromagnet.
- 2.F.04.05 Test and use a relay.
- 2.F.04.06 Describe, calculate, simulate and measure transformer characteristics including turns ratio, voltage, current, power and efficiency.

2.F.04 Performance Example:
- Explain the operation of and use a transformer in a circuit.

2.F.05 Explain the scientific principles of and use AC circuits.
- 2.F.05.01 Calculate RMS, Peak, Peak to Peak, and average values of a periodic waveform.
- 2.F.05.02 Calculate frequency, period and duty cycle of a periodic waveform.

2.F.05 Performance Example:
- Measure the period, peak value and peak to peak value of a sine wave with an oscilloscope.

2.F.06 Design, build and test electronic circuits using diodes and transistors.
- 2.F.06.01 Explain how a PN junction works.

2.F.06.02 Design, simulate, build, and test a half wave rectifier.
2.F.06.03 Design, simulate, build, and test a full wave rectifier.
2.F.06.04 Design, simulate, build and test a transistor as a switch.
2.F.06.05 Explain transistor bias point and how it relates to cutoff and saturation.

2.F.06 Performance Example:
- Design, build and test a full wave rectifier.

2.F.07 Explain the principles and characteristics of different types of electric motors.
- 2.F.07.01 Name and explain the function of the main parts of a DC motor – field, armature, brushes, commutator.
- 2.F.07.02 Explain the operation of DC motors, both self-excited and separately excited.
- 2.F.07.03 Explain the performance characteristics of series wound, shunt wound, and compound wound of DC motors.
- 2.F.07.04 Name and explain the function of the main parts of an AC motor, both rotor and stator (squirrel cage).
- 2.F.07.05 Differentiate between both induction and synchronous AC motors.
- 2.F.07.06 Explain the concept of three phase motors.

2.F.07 Performance Example:
- Disassemble and explain the parts of an electric motor.

2.F.08 Explain the basics of electric power transmission and distribution.
- 2.F.08.01 Explain the basics of power generation.
- 2.F.08.02 Explain the basics of three phase power.
- 2.F.08.03 Explain the basics of power transmission.
- 2.F.08.04 Explain the various high voltage values used in transmission.
- 2.F.08.05 Explain the various voltage values used in local distribution.
- 2.F.08.06 Explain the local distribution of power.

2.F.08 Performance Example:
- Explain the generation and distribution of electrical power.

2.F.09 Explain, design, simulate, and build combinational digital logic circuits.
- 2.F.09.01 Find and read specification sheets for various ICs.
- 2.F.09.02 Explain the basic gates AND, OR, INVERT, NAND, NOR, XOR.
- 2.F.09.03 State and use truth tables for the basic gates.
- 2.F.09.04 Create a truth table from a given word problem.
- 2.F.09.05 Create Sum of Products (SOP) Boolean expressions from a given truth table.
- 2.F.09.06 Simulate the logic diagram.
- 2.F.09.07 Build and test the logic diagram.
- 2.F.09.08 Troubleshoot the circuit.
- 2.F.09.09 Convert the SOP circuit to NAND gates.
- 2.F.09.10 Convert the SOP circuit to NOR gates.
- 2.F.09.11 Use DeMorgan's Laws to convert and build an alternative implementation of a circuit.
- 2.F.09.12 Design circuits using reprogrammable logic devices.

2.F.09 Performance Example:
- Design, build, test, troubleshoot and analyze a Combinational Logic Circuit.

2.F.10 Explain, design, simulate, and build sequential digital logic circuits.
- 2.F.10.01 Create timing diagrams and truth tables for D flip-flops and JK flip-flops.

2.F.10.02 Design, simulate and build up/down asynchronous and synchronous counters using D/JK flip-flops.
2.F.10.03 Build similar circuits using MSI circuits.

2.F.10 Performance Example:
- Design, build, test, troubleshoot and analyze a Sequential Logic Circuit.

2.F.11 Use and convert integers within the given number systems.
2.F.11.01 Perform conversions from decimal to binary and from binary to decimal.
2.F.11.02 Perform conversions from decimal to hex and from hex to decimal.
2.F.11.03 Perform conversions from binary to hex and from hex to binary.

2.F.11 Performance Example:
- Convert numbers between the three number systems and explain where each would be used.

2.G Fundamentals of Sensor Technologies

2.G.01 Explain the characteristics and operation of position sensors.
2.G.01.01 Describe the operation and use of a potentiometer to measure mechanical movement in a control system.
2.G.01.02 Design and build a circuit used to demonstrate the use of a potentiometer to measure mechanical movement in a control system.
2.G.01.03 Describe the operation and use of absolute and incremental optical rotary encoders.
2.G.01.04 Design and build a circuit using absolute and incremental optical rotary encoders.

2.G.01 Performance Example:
- Students will draw schematic symbols of potentiometers, describe their operation, and give examples of their use in mechanical systems used to measure mechanical movement. Students will also describe the use of incremental and absolute encoders used to measure mechanical movement.

2.G.02 Explain the characteristics and operation of velocity sensors.
2.G.02.01 Describe the operation and use of optical tachometers.
2.G.02.02 Design and build a circuit used to demonstrate the operation of optical tachometers.
2.G.02.03 Describe the operation and use of direct current transformers.
2.G.02.04 Design and build a circuit used to demonstrate the operation of direct current tachometers.

2.G.02 Performance Example:
- Students will design, build, and test a circuit using a velocity sensor.

2.G.03 Explain the characteristics and operation of proximity sensors.
2.G.03.01 Describe the operation and use of a mechanical limit switch in a control system.
2.G.03.02 Describe the operation, use of, and modes of operations for optical proximity sensors, including photo resistors, photodiodes, phototransistors and photovoltaic cells.
2.G.03.03 Describe the operation and use of ultrasonic proximity sensors in a control system.
2.G.03.04 Describe the operation and use of inductive and capacitive proximity sensors.
2.G.03.05 Describe the operation and use of hall-effect proximity sensors.

2.G.03.06 Design and build a circuit using one or more of the above proximity sensors.

2.G.03 Performance Example:
- Students will design, build and test a circuit using any type of proximity sensor.

2.G.04 Explain the characteristics and operation of load and force sensors.
- 2.G.04.01 Describe the operation and the use of strain gauges in a control system.
- 2.G.04.02 Design and build a circuit used to demonstrate the use of a strain gauge in a control system.

2.G.04 Performance Example:
- Students will design, build and test a circuit using a strain gauge.

2.G.05 Explain the characteristics and operation of pressure sensors.
- 2.G.05.01 Describe the operation and use of a pressure sensor in a control system.
- 2.G.05.02 Design and build a circuit used to demonstrate the use of a pressure sensor in a control system.

2.G.05 Performance Example:
- Students will design, build and test a circuit using a pressure sensor.

2.G.06 Explain the characteristics and operation of temperature sensors.
- 2.G.06.01 Describe the operation and use of a RTD in a temperature control system.
- 2.G.06.02 Design and build a circuit used to demonstrate the operation and use of a RTD (Resistor Temperature Device) in a temperature control system.
- 2.G.06.03 Describe the operation and use of a thermistor in a temperature control system.
- 2.G.06.04 Design and build a circuit used to demonstrate the operation and use of a thermistor in a temperature control system.
- 2.G.06.05 Describe the operation and use of a thermocouple in a temperature control system.
- 2.G.06.06 Design and build a circuit used to demonstrate the operation and use of a thermocouple in a temperature control system.
- 2.G.06.07 Describe the operation and use of an integrated-circuit temperature sensor in a temperature control system.
- 2.G.06.08 Design and build a circuit used to demonstrate the operation and use of an integrated-circuit sensor in a temperature control system.

2.G.06 Performance Example:
- Students will design, build and test a circuit using a temperature sensor.

2.H Programmable Logic Controller Foundations and Programming Concepts

2.H.01 Name and explain the basic building blocks of a programmable logic controller (PLC).
- 2.H.01.01 Identify the major advantages in the use of PLCs in automation.
- 2.H.01.02 Identify the major components of a PLC.
- 2.H.01.03 Define fixed and modular PLCs and give advantages of both types.
- 2.H.01.04 Identify the various programming devices used to program a PLC.
- 2.H.01.05 Explain the various modes of operations of a PLC.
- 2.H.01.06 Identify the criteria used in categorizing PLCs including functionality, number of inputs and outputs, cost, and physical size.

2.H.01 Performance Example:
- Students will develop a schematic diagram of a typical PLC system and identify all components and describe their function.

2.H.02 Identify and explain PLC hardware components.

2.H.02.01 Identify the input/output (I/O) section of a PLC and field device connections.
2.H.02.02 Describe PLC I/O addressing formats.
2.H.02.03 Describe the specifications, use and operation of Discrete I/O modules.
2.H.02.04 Describe the specifications, use and operation of Analog I/O modules.
2.H.02.05 Describe the specifications, use and operation of Specialty I/O modules.
2.H.02.06 Identify the Central Processing Unit (CPU) of a PLC.
2.H.02.07 Identify the power supply of a PLC and its specifications.
2.H.02.08 Identify PLC memory types and designs.
2.H.02.09 Describe the various Terminal Programming Devices used to program PLCs.
2.H.02.10 Explain Human Machine Interfaces (HMI's) and their applications.

2.H.02 Performance Example:
- Students will develop a schematic diagram of typical Input and Output configurations and correctly address using the specific manufacture's addressing formats.

2.H.03 Demonstrate an understanding of the fundamentals of PLC Logic.

2.H.03.01 Explain the Binary Concept and its use in PLC applications.
2.H.03.02 Explain the basic digital gate functions, AND, OR, INVERTER, and their applications in PLC logic.
2.H.03.03 Identify the role of Boolean algebra and its application in PLC logic simplification.
2.H.03.04 Develop equivalent PLC logic from Logic Gate Circuits derived from Boolean Expressions.
2.H.03.05 Develop equivalent PLC logic from Boolean Expressions derived from Logic Gate Circuits.

2.H.03 Performance Example:
- Students will develop simple PLC logic programs to replicate digital gate functions, i.e. AND, OR, and INVERTER functions. Students will further develop PLC logic programs derived from Boolean Expressions and Logic Gate Circuits.

2.H.04 Demonstrate an understanding of the fundamentals of PLC programs and PLC wiring diagrams.

2.H.04.01 Explain the role of electromagnetic relays and their role in PLC programming and PLC wiring diagrams.
2.H.04.02 Explain the NO and NC contacts and develop equivalent PLC programming and PLC wiring diagrams.
2.H.04.03 Develop PLC programming and PLC wiring diagrams using motor starters and contactors.
2.H.04.04 Develop PLC programming and PLC wiring diagrams using manually operated switches.
2.H.04.05 Develop PLC programming and PLC wiring diagrams using various sensors.
2.H.04.06 Develop PLC programming and PLC wiring diagrams from electromagnetic relay logic.
2.H.04.07 Develop PLC programming and PLC wiring diagrams directly from a narrative description.

2.H.04.08 Develop PLC programs using various delay and retentive timers.
2.H.04.09 Develop various PLC programs using various counters.
2.H.04.10 Develop PLC programs using Program Control Instructions, Master Control Reset, Jump, and Subroutines.
2.H.04.11 Develop PLC programs using Data Manipulation and Data Compare Instructions.
2.H.04.12 Develop PLC programs using basic Math Functions.
2.H.04.13 Develop PLC programs using Sequencer and Shift Register Instructions.
2.H.04.14 Develop PLC programs using programming blocks for analog inputs and outputs and PID (Proportional Integral Derivative) control.
2.H.04.15 Develop HMI (Human Machine Interface) programs to allow the user to view the PLC operation in real time, change timer or counter values and replace hardwired input and output devices.

2.H.04 Performance Example:
- Students will wire Inputs and Output devices to a PLC system. Students will develop PLC logic programs from a narrative description using timer, counter and advanced ladder programming instructions to automate a system. System may include the use of a Human Machine Interface HMI) device to complete the given task.

2.I Robotics Technology

2.I.01 Name and explain the basic building blocks and critical specifications of an industrial robot.
2.I.01.01 Identify classification by arm geometry.
2.I.01.02 Define the following robot terms: degrees of freedom, position axes, orientation axes, work envelope, tool center point.
2.I.01.03 Define and give an example of the following specifications for industrial robots: payload, repeatability, memory capacity, and environmental requirements.
2.I.01.04 Identify the various actuators used by a typical industrial robotic arm.
2.I.01.05 Identify the various drive mechanisms used by a typical industrial robotic arm.
2.I.01.06 Identify the various controllers used by a typical industrial robot.
2.I.01.07 Identify the various power sources used by a typical industrial robot.
2.I.01.08 Describe various end-of-arm tooling used by an industrial robot.
2.I.01.09 Identify various teaching and programming devices used to accurately program an industrial robot.
2.I.01.10 Describe various data storage devices used by a typical industrial robot.

2.I.01 Performance Example:
- Students will draw and label the basic building blocks of an industrial robot using the appropriate robotic terminology. Drawings will include examples of degrees of freedom, work envelope, position axes, actuators, drive mechanisms, controllers, power sources, and end of arm tooling.

2.I.02 Explain industrial robot characteristics and classifications.
2.I.02.01 Describe open-loop and close-loop control systems.
2.I.02.02 Identify an industrial robot's classification.
2.I.02.03 Describe the various arm geometries employed in industrial robots.
2.I.02.04 Describe the various power sources used by industrial robots.
2.I.02.05 Explain the various path control techniques used by industrial robots.

2.I.02 Performance Example:
- Students will draw and label electrical diagrams showing open-loop and close-loop industrial robot systems.

2.I.03 Explain the use of industrial robot work-cell sensors.
- 2.I.03.01 Describe the operation and use of simple contact sensors.
- 2.I.03.02 Describe the operation and use of simple noncontact sensors.
- 2.I.03.03 Describe the operation and use of process control sensors.

2.I.03 Performance Example:
- Students will develop and test simple industrial robot programs designed to show the operation of contact and noncontact sensors used with industrial robots.

2.I.04 Explain various end-of-arm tooling with industrial robots.
- 2.I.04.01 Define given tooling terms.
- 2.I.04.02 Identify various tooling power sources.
- 2.I.04.03 Identify various grippers: standard, servo, nonservo, vacuum, and magnetic.

2.I.04 Performance Example:
- Students will develop and test simple industrial robot programs designed to show the use of various end-of-arm tooling used with industrial robots.

2.I.05 Explain robot teaching and programming techniques.
- 2.I.05.01 Identify the complexities of work-cell programming.
- 2.I.05.02 Identify the functions of the controller used.
- 2.I.05.03 Explain on-line programming, methods used to and how it is accomplished.
- 2.I.05.04 Explain off-line programming, methods used to and how it is accomplished.

2.I.05 Performance Example:
- Students will develop and test a fully automated industrial robot program designed to operate a close-loop industrial robot system derived from a narrative description or system design specifications.

2.I.06 Build and program a mobile robot.
- 2.I.06.01 Assemble and build a mobile robot.
- 2.I.06.02 Create and load code to operate the mobile robot.
- 2.I.06.03 Control the robot using a remote control unit.
- 2.I.06.04 Control the robot; move forward, backward, turn and use different power levels in autonomous mode.
- 2.I.06.05 Use sensors to detect external conditions and to control the robot's operation.
- 2.I.06.06 Use loops and conditional statements in the program.

2.I.06 Performance Example:
- Students will design, build, program and test a mobile robotic system.

2.J Automated Systems

2.J.01 Design, simulate, build, or research at least two of the following industrial systems.
- 2.J.01.01 Motor Control application.
- 2.J.01.02 Punch press application.
- 2.J.01.03 Clamp and drill routine.
- 2.J.01.04 Injection molding machine.
- 2.J.01.05 Robot gripper and control routine.
- 2.J.01.06 Palletizing routine.

2.J.01.07 Batch Process routine.
2.J.01.08 Sorting process.
2.J.01.09 Mobile robot application.
2.J.01.10 Robotic work station.

2.J.01 Performance Example:
- Research and design a power point presentation to explain at least (2) of automation systems given.

Strand 5: Management and Entrepreneurship Knowledge and Skills

5.A Starting a Business

5.A.01 Demonstrate an understanding of the practices required to start a business.

- 5.A.01.01 Define entrepreneurship and be able to recognize and describe the characteristics of an entrepreneur.
- 5.A.01.02 Compare and contrast types of business ownership (i.e., sole proprietorships, franchises, partnerships, corporations).
- 5.A.01.03 Identify and explain the purpose and contents of a business plan.
- 5.A.01.04 Demonstrate an understanding of the principles and concepts of a business's supply chain (i.e., suppliers, producers and consumers.

5. A Performance Examples:

- Develop a presentation pertaining to an entrepreneur and their business.
- Communicate with a business owner and discuss the pros and cons of starting and owning a business. Summarize the main points of the discussion.
- Choose a product or service and describe the process leading to distribution.
- Write a business plan for a business in your community.

5.B Managing a Business

5.B.01 Demonstrate an understanding of managing a business.

- 5.B.01.01 Formulate short- and long-term business goals.
- 5.B.01.02 Demonstrate effective verbal, written and visual communication skills.
- 5.B.01.03 Utilize a decision-making process to make effective business decisions.
- 5.B.01.04 Identify a business's chain of command and define its organizational structure.
- 5.B.01.05 Identify and apply effective customer service skills and practices.
- 5.B.01.06 Identify, interpret and develop written operating procedures and policies.
- 5.B.01.07 Track inventory, productivity and labor cost.
- 5.B.01.08 Demonstrate business meeting skills.
- 5.B.01.09 Identify professional organizations and explore their benefits.

5. B Performance Examples:

- Working as a team, role-play situations that an entrepreneur might face in dealing with customers or employees.
- Contact a relevant professional organization and request information about its benefits, membership requirements and costs.
- Plan and conduct a business meeting.
- Identify companies that are known for customer service and list the practices that help differentiate themselves from all others in their industry.

5.C Marketing a Business

5.C.01 Demonstrate an understanding of marketing and promoting a business.

- 5.C.01.01 Explain the role of business in the economy.
- 5.C.01.02 Describe the relationship between business and community.
- 5.C.01.03 Describe methods of market research and identifying target markets.

5.C.01.04 Describe and apply the concepts of a marketing mix (the 4Ps of marketing: product, price, place and promotion).
5.C.01.05 Compare and contrast the promotional tools and techniques used to sell products, services, images and ideas.
5.C.01.06 Describe the impact of supply and demand on a product or business.
5.C.01.07 Identify direct and indirect competition on a business.
5.C.01.08 Identify and use sales techniques to meet client needs and wants.
5.C.01.09 Discuss strategies to acquire and retain a customer base.

5. C Performance Examples:
- Research reliable sources to identify marketing and industry data related to a business.
- Conduct market research by developing a survey and presenting the results.
- Create a promotional campaign using a variety of media.
- Write a marketing plan for a product.

5.D Financial Concepts and Applications in Business

5.D.01 Demonstrate an understanding of financial concepts and applications.

5.D.01.01 Identify essential financial reports and understand their purpose (i.e., budget, balance sheet and income statement).
5.D.01.02 Describe payroll practices (i.e., deductions – federal, FICA and state taxes and insurances).
5.D.01.03 Identify the importance of maintaining accurate records.
5.D.01.04 Apply practices related to pricing, purchasing and billing.
5.D.01.05 Maintain and reconcile a checking account.
5.D.01.06 Identify the options for funding a business.

5. D Performance Examples:
- Given an employee time card and rate of pay, calculate gross pay, taxes, deductions and net pay.
- Develop a budget for a simulated business or project.
- Analyze and discuss financial documents from a company.
- Research various methods of funding a business.

5.E Legal/Ethical/Social Responsibilities

5.E.01 Demonstrate an understanding of legal, ethical and social responsibility for businesses.

5.E.01.01 Identify state and federal laws and regulations related to managing a business.
5.E.01.02 Describe and identify ethical business practices.
5.E.01.03 Demonstrate an understanding of business contracts.
5.E.01.04 Explain the role of diversity in the workplace.
5.E.01.05 Explain the role of labor organizations.
5.E.01.06 Identify practices that support clean energy technologies and encourage environmental sustainability.
5.E.01.07 Demonstrate an understanding of how technology advancements impact business practices.

5.E Performance Example:
- Read and interpret a contract.
- Complete an application for a license, permit or certificate.
- Research federal, state and local regulations and laws required for a business.
- Participate in and summarize a discussion with a member of a labor or civil rights organization.

Selected Websites

- CVTE Strand 1, 4, and 5 Resources: https://sites.google.com/a/mccanntech.org/cvte-strands-1-4-and-5-resources/
- Entrepreneur: http://www.entrepreneur.com
- Inc. Magazine: http://www.inc.com/
- Junior Achievement "Be Entrepreneurial Program": https://www.juniorachievement.org/web/ja-usa/home
- Kahn Academy Interviews with Entrepreneurs: https://www.khanacademy.org/economics-finance-domain/entrepreneurship2/interviews-entrepreneurs
- Kauffman Founders School: http://www.entrepreneurship.org/en/founders-school.aspx
- National Federation of Independent Business: www.nfib.com
- National Foundation for Teaching Entrepreneurship (NFTE): www.nfte.com
- SBA Loans: http://www.sba.gov
- SkillsUSA Professional Development Program Competency List: http://www.skillsusa.org/downloads/PDF/lessons/professional/PDPPreview.pdf
- Small Business Administration: www.sba.gov

Glossary

Term	**Definition**
Balance sheet	A statement of the assets, liabilities and capital of a business at a particular point in time.
Budget	An estimate of income and expenditure for a set period of time.
Business Ownership	Types of business ownership refer to the legal structure of an organization. Legal structures include: Sole Proprietorship, Partnerships, Corporations and Limited Liability Companies.
Business Plan	A written document that describes in detail your business goals and how you are going to achieve them from a marketing, operational and financial point of view.