

Engineering Technology (2014)

Engineering Safety Health and Skills 2.A

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

- 1 Implement safety knowledge obtained on a continuous basis. 2.A.01.01
 - 2 Identify safety hazards in the shop, remove hazards, and develop continuous improvement solutions. 2.A.01.02
 - 3 Implement a tag-out and lock-out shop procedure. 2.A.01.03
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2 Read, explain and implement shop safety manual and procedures according to current industry and OSHA standards. 2.A.02

- 1 Demonstrate safety procedure(s) for maintaining machinery and equipment. 2.A.02.01
 - 2 Demonstrate safety procedure(s) for operating machinery and equipment. 2.A.02.02
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Engineering – Introductory Knowledge and Skills 2.B

1 Demonstrate and apply the design process. 2.B.01

- 1 Identify a problem to be solved based on identifying customer needs. 2.B.01.01
- 2 Brainstorm ideas; develop and evaluate solutions; create documentation; build and test prototype; and present design. 2.B.01.02
- 3 Create new designs by working in teams using brainstorming techniques. 2.B.01.03
- 4 Maintain an engineering journal to document design solutions. 2.B.01.04
- 5 Conduct market surveys, research patents, search internet sources, contact companies, and develop justification for at least three solutions of given engineering problems/customer needs.. 2.B.01.05
- 6 Develop best solution, sketch and model idea, survey market and customers, produce a timeline, develop industry support, report results periodically, re-evaluate solution, develop criteria and limitations and produce initial drawings. 2.B.01.06
- 7 Describe the role of drawings and CAD models as vital documentation components in the engineering process. 2.B.01.07
- 8 Fabricate a prototype using hand tools, manual machine tools, CNC devices, joining processes, measuring and cutting techniques. 2.B.01.08
- 9 Develop testing protocol, test and evaluate prototype, assess performance and function, and modify design based upon results. 2.B.01.09
- 10 Produce final drawing documentation, develop presentation, present results; patent, market, and sell idea. 2.B.01.10

2 Demonstrate skills in problem solving, diagnostics, and troubleshooting. 2.B.02

- 1 Identify the components and process of the system (equipment). 2.B.02.01
- 2 Identify the problem or source of the problem. 2.B.02.02
- 3 Develop solutions using a structured problem solving process. 2.B.02.03
- 4 Use appropriate testing equipment and tools for diagnosing the problem. 2.B.02.04
- 5 Implement the appropriate strategies to remedy the problem. 2.B.02.05

3 Define and describe types of engineering. 2.B.03

- 1 Describe different pathways towards a variety of engineering careers. 2.B.03.01
- 2 Explain how engineers impact society, the environment, economy, and daily life through their work. 2.B.03.02
- 3 Identify the unique components and considerations of the different engineering fields (e.g., civil/structural, transportation, electrical, computer, software, manufacturing, mechanical, and biological/environmental/chemical). 2.B.03.03
- 4 List the attributes of design in a variety of technical fields (e.g., biotechnology, manufacturing, environmental, power and energy, transportation, etc.). 2.B.03.04
- 5 Describe one major engineering category or sub-discipline and describe core tasks, working conditions, salary, education and training, skills and abilities required. 2.B.03.05

4 Document and communicate engineering concepts. 2.B.04

- 1 Write a technical design report. 2.B.04.01
- 2 Maintain engineering logs/notebooks/journals and portfolios for projects. 2.B.04.02
- 3 Utilize a variety of media formats to convey designs and processes (animation, presentation software, web page, etc.). 2.B.04.03

5 Develop project or product objectives and criteria. 2.B.05

- 1 Define requirements for a project or product. 2.B.05.01
- 2 Create specifications (or follow if given) for a project or product. 2.B.05.02
- 3 Establish milestones for a project or product. 2.B.05.03
- 4 Develop a time line for a project or product. 2.B.05.04
- 5 Identify critical path components. 2.B.05.05
- 6 Implement a schedule for a project or product. 2.B.05.06

6 Develop methods and plan of production. 2.B.06

- 1 Determine method to be used to create a product (molding, machining, etc.). 2.B.06.01
- 2 Define efficient order of fabrication operation. 2.B.06.02
- 3 Identify parts and materials for product. 2.B.06.03
- 4 Make custom parts (those not readily available that meet specifications). 2.B.06.04
- 5 Assemble a product. 2.B.06.05

7 Explain, demonstrate and apply manufacturing process management techniques according to current industry and OSHA standards. 2.B.07

- 1 Identify internal and external customer needs. 2.B.07.01
- 2 Identify resources needed (supplies, personnel, equipment). 2.B.07.02
- 3 Identify/create/provide needed standard operational procedures (SOPs). 2.B.07.03
- 4 Monitor process using process control data. 2.B.07.04
- 5 Explain inventory control and the implications to production and performance. 2.B.07.05
- 6 Test product to verify that it meets customer specifications, regulations, etc. 2.B.07.06
- 7 Demonstrate process used to document and ensure compliance. 2.B.07.07
- 8 Insure timely delivery of product to customer. 2.B.07.08

8 Apply principles of 'world class' operations (i.e., industry quality standard operation). 2.B.08

- 1 Explain quality control techniques as applied to manufacturing/engineering and technical processes. 2.B.08.01
- 2 Identify and apply the concepts of total quality management (TQM) appropriate to the field. 2.B.08.02
- 3 Assess a plan for continuous improvement. 2.B.08.03

9 Apply industrial design and packaging. 2.B.09

- 1 Explain the different elements of industrial design including branding, usability, ergonomics, sustainability, maintainability, aesthetics, etc. 2.B.09.01
- 2 Design a packaging solution for a product (such as food, hair care, a tool, etc.). Explain the purposes, goals, and the risks and benefits of your design choices. 2.B.09.02

10 Explain introductory engineering concepts. 2.B.10

- 1 Define and use engineering notations and prefixes: tera, giga, mega, kilo, milli, micro, nano, pico. 2.B.10.01
 - 2 Explain Prior Technologies in several common engineering areas. 2.B.10.02
 - 3 Complete a reverse engineering process for a design or device. 2.B.10.03
 - 4 Use both metric and English systems of measurements. 2.B.10.04
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**Electrical Engineering
Demonstration, Design,
and
Implementation** 2.C

1 Demonstrate introductory electrical engineering knowledge and skills. 2.C.01

- 1 Identify appropriate test devices for specific tasks (e.g., oscilloscope or multimeter). 2.C.01.01
- 2 Calibrate and use test devices accurately (e.g., oscilloscope or multimeter). 2.C.01.02
- 3 Read and interpret schematics. 2.C.01.03

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- 2 Explain and apply electrical engineering principles, and techniques and use design tools and materials according to current industry and OSHA standards.. 2.C.02**
- 1 Label and describe the parts of an atom. 2.C.02.01
 - 2 Explain what classifies a material as an insulator, conductor, or semiconductor. 2.C.02.02
 - 3 Describe resistance and what its function is in circuit design. 2.C.02.03
 - 4 Identify resistors using color code. 2.C.02.04
 - 5 Measure resistance using multimeters. 2.C.02.05
 - 6 Identify basic circuit components (source, load, control, and conductors). 2.C.02.06
 - 7 Describe different types and functions of switches. 2.C.02.07
 - 8 Calculate voltage, current and resistance in circuits using Ohm's law. 2.C.02.08
 - 9 Calculate current and voltage using Kirchhoff's law. 2.C.02.09
 - 10 Measure voltage, current, and resistance in both series and parallel circuits. 2.C.02.10
 - 11 Describe the differences among series, parallel, and series-parallel circuits. 2.C.02.11
 - 12 Measure the value of capacitors using instrumentation. 2.C.02.12
 - 13 Identify different types of capacitors, their values, and their voltage polarity requirements. 2.C.02.13
 - 14 Differentiate between direct and alternating currents. 2.C.02.14
 - 15 Draw and label waveforms (e.g., square, sawtooth, and sine). 2.C.02.15
 - 16 Determine rise time, fall time, frequency, and amplitude using an oscilloscope. 2.C.02.16
 - 17 Demonstrate the operation of diodes and describe their function. 2.C.02.17
 - 18 Demonstrate the operation of transistors and describe their function. 2.C.02.18
 - 19 Describe the differences among display devices: LED (light emitting diodes), seven segment display and LCD (liquid crystal display). 2.C.02.19
 - 20 Locate logic families in a reference catalog. 2.C.02.20
 - 21 Read specification sheets on an individual IC to determine suitability for use in a given circuit. 2.C.02.21
 - 22 Perform conversions between binary and decimal, hexadecimal and binary, and hexadecimal and decimal. 2.C.02.22
 - 23 Use schematics and symbolic algebra to represent digital gates as part of a solution to a design problem (logic symbols: AND, OR, NOT, NAND, NOR, XOR and X-NOR gates). 2.C.02.23
 - 24 Create Boolean expressions and truth tables. 2.C.02.24
 - 25 Select min-term and max-term expressions (sum of product: SOP, product of sum: POS). 2.C.02.25

- 26 Use DeMorgan's theorem to convert a SOP to a POS in order to save resources in the production of circuits. 2.C.02.26
 - 27 Formulate and use a Karnaugh Map and/or Boolean algebra to reduce logic equation. 2.C.02.27
 - 28 Describe duality of logic functions. 2.C.02.28
 - 29 Simplify, solve, construct, and demonstrate a circuit from a digital word problem. 2.C.02.29
 - 30 Design circuits using reprogrammable logic devices. 2.C.02.30
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3 Build and implement electrical engineering circuits. 2.C.03

- 1 Simulate a circuit. 2.C.03.01
 - 2 Construct a circuit. 2.C.03.02
 - 3 Troubleshoot problems with a circuit. 2.C.03.03
 - 4 Create PLD (Programmable Logic Devices) logic files. 2.C.03.04
 - 5 Construct and test simple latches and flip-flops from discrete gates. 2.C.03.05
 - 6 Interpret, design, draw, and evaluate circuits using logic symbols (triggers, latches, flip-flops). 2.C.03.06
 - 7 Create timing diagrams and truth tables for J-K flip-flop. 2.C.03.07
 - 8 Analyze timing diagrams. 2.C.03.08
 - 9 Explain timing requirements of ICs. 2.C.03.09
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Mechanical Engineering Demonstration, Design, and Implementation 2.D

- 1 Demonstrate introductory mechanical engineering knowledge and skills. 2.D.01**
 - 1 Identify the various industry-wide prototyping methods in use. 2.D.01.01
 - 2 Describe common engineering plastics, processing, additives, fillers, colorants, modifiers, and their effects on properties. 2.D.01.02
 - 3 Select suitable materials for a given application. 2.D.01.03
 - 4 Use the measurement units of mass, length, angles and time and their extensions (e.g., velocity, density) 2.D.01.04
 - 5 Identify and use devices and gauges (i.e. rulers, scales, timers, calipers, radius gauges, protractors) to accurately measure units of mass, length, angles, and time and their extensions. 2.D.01.05
 - 6 Calibrate mechanical measurement devices and gauges. 2.D.01.06
 - 7 Interpret detail and assembly drawings, technical processes, procedures, and instructions. 2.D.01.07
 - 8 Extract and analyze properties of mass (i.e. volume, density, moment of inertia, etc.). 2.D.01.08
 - 9 Evaluate the function and operation of assembly (motion, interference, etc.) of a mechanical design. 2.D.01.09
 - 10 Demonstrate ethical challenges facing engineers in the design, redesign, repair and implementation of products. 2.D.01.10
 - 11 Demonstrate various classes and subclasses of common engineering materials (e.g., organics, metals, polymers, ceramics, and composites) and their properties (solid, liquid, and plasma gas) from macrostructure to microstructure. 2.D.01.11
 - 12 Demonstrate the use and application of the various classes and subclasses of materials. 2.D.01.12
 - 13 Demonstrate property changing treatments (i.e. heat, chemical, additives, etc) in a variety of materials. 2.D.01.13
 - 14 Describe and define the process of casting and molding as it relates to the engineering process and fabrication. 2.D.01.14
 - 15 Trace the production of engineering materials from raw material to finished product as well as disposal, recycling, and describe the environmental impact of each process. 2.D.01.15
 - 16 Demonstrate how the properties of materials and their use influences the reliability of a mechanical design (i.e. Mean Time Between Failure: MTBF, etc.) 2.D.01.16
 - 17 Describe how design choices will affect the likelihood of safety and liability issues arising within the end use of a designed product. 2.D.01.17
 - 18 Explain and demonstrate where material removal or addition would be the appropriate process to use in production (e.g., turning, milling, grinding, and plating). 2.D.01.18
 - 19 Describe the process of forming (e.g., bending, forging, cutting, etc). 2.D.01.19
 - 20 Explain how design choices will affect the ease and efficiency of manufacturing the designed product. 2.D.01.20

2 Explain and apply mechanical engineering principles and techniques, and use design tools and materials according to current industry and OSHA standards. 2.D.02

- 1 Define geometric shapes, line types, tools, and describe constraints used in sketching. 2.D.02.01
- 2 Prepare clear and accurate hand sketches using orthographic and perspective views. 2.D.02.02
- 3 Prepare clear and accurate hand sketches using annotative labels including materials, processes, functions and dimensions. 2.D.02.03
- 4 Apply scale, dimensioning, and tolerance standards to drawings. 2.D.02.04
- 5 Define and implement Geometric Dimensioning and Tolerancing (GD&T) for production drawings. Create and edit a solid model using a 3-D modeling program, based upon design sketches. Utilize appropriate materials, measurements, fits, appearances, processes and functions. 2.D.02.05
- 6 Combine model parts into working assembly, manipulate and animate assembly using a 3-D modeling program. 2.D.02.06
- 7 Analyze parts and assemblies with respect to safety, handling, end user, production, cost, packaging, and environmental impact. 2.D.02.07
- 8 Create detail and assembly drawings based upon 3-D models. 2.D.02.08
- 10 Annotate detail drawings with dimensions, materials, processes and appropriate views. 2.D.02.10
- 11 Create section, detail, broken-out, break, and auxiliary views. 2.D.02.11
- 12 Create an assembly drawing with: balloons, a parts list containing items, quantities, descriptions and part numbers, appropriate assembly notes; and a titleblock based upon 3-D models. 2.D.02.12
- 13 Create a numbering system for each drawing set. 2.D.02.13
- 14 Identify, describe and prescribe ferrous and non-ferrous metals, plastics, ceramics and composites, based upon their micro and macro structures, relationship between micro structure and properties, common property changing procedures and treatments. 2.D.02.14
- 15 Design items using common engineering plastics based upon their processing, additives, fillers, colorants, modifiers and the effects on properties. 2.D.02.15
- 16 Analyze, describe, and test the concepts of simple machines: gears, pulleys, lever, wheel and axle, wedge and screw, and determine their mechanical advantages. 2.D.02.16
- 17 Analyze, describe, and test fluid systems based upon flow, pressure, density, temperature, elevation, and friction. 2.D.02.17
- 18 Analyze, describe, and test heat flow systems based upon conduction, convection, and radiation, and perform heat loss calculations. 2.D.02.18
- 19 Analyze, describe and test basic beam deflection relationships; stress, strain, tension, compression, torsion, moments for common cross-sectional shapes and

materials using such techniques as finite element analysis (FEA). 2.D.02.19

- 20 Construct free body diagrams, resolve forces into vector components, solve static equations and calculate stress, strain, deflection, moment of inertia, linear and angular velocity and acceleration. 2.D.02.20
 - 21 Identify where material joining would be the appropriate process to use in production (gluing, welding, etc.) 2.D.02.21
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3 Build and implement mechanical engineering designs. 2.D.03

- 1 Use industry-wide prototyping methods including rapid-prototyping. 2.D.03.01
 - 2 Build a prototype model from a drawing database. 2.D.03.02
 - 3 Set up and operate a basic manufacturing assembly process, resulting in a finished product. 2.D.03.03
 - 4 Build mechanical parts utilizing techniques such as turning, milling, cutting, bending, etc. 2.D.03.04
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**Automated Systems
Engineering
Demonstration, Design,
and Implementation 2.E**

1 Demonstrate automated systems engineering introductory knowledge and skills. 2.E.01

- 1 Define an automated system and a robot. 2.E.01.01
- 2 Evaluate the impact robots have on manufacturing and society. 2.E.01.02
- 3 Classify different types of robots. 2.E.01.03
- 4 Identify specifications for the work envelope of a robot. 2.E.01.04
- 5 Identify and sketch the components of a robot. 2.E.01.05
- 6 Describe servo, stepper and DC motors and possible uses. 2.E.01.06
- 7 Describe the components of robot controllers. 2.E.01.07
- 8 Select, size, and implement interface device(s) to control a motor(s). 2.E.01.08
- 9 Describe ways an end effector is specific to a process. 2.E.01.09
- 10 Explain the need for end of arm tooling and how it affects the robot's operation. 2.E.01.10
- 11 Describe various applications of a programmable logic controller (PLC) as related to its use in a computer integrated manufacturing (CIM) system. 2.E.01.11
- 12 Describe the difference between a PLC and a computer with interface. 2.E.01.12
- 13 Identify individual components used in CIM systems. 2.E.01.13
- 14 Explain the significance of teamwork and communication when combining the designs of the individual groups into a complete model of Flexible Manufacturing Systems (FMS). 2.E.01.14
- 15 Differentiate between open and closed loop control. 2.E.01.15
- 16 Design and create a program to evaluate data and make decisions using external digital and analog sensors. 2.E.01.16
- 17 Formulate a flow chart to correctly apply basic programming concepts. 2.E.01.17
- 18 Describe the function of sensors in electronic circuitry (temp., optical, etc.). 2.E.01.18
- 19 Explain the principles of control techniques and computer simulations. 2.E.01.19
- 20 Compare and contrast the benefits and drawbacks of the three categories of CIM manufacturing systems. 2.E.01.20
- 21 Describe the working relationship between the CNC mill and the robot. 2.E.01.21
- 22 Analyze and select CIM system components for a specific industrial application. 2.E.01.22

2 Explain and apply automated systems engineering principles and techniques, and use design tools and materials according to current industry and OSHA standards. 2.E.02

- 1 Design an end effector. 2.E.02.01
- 2 Design a working model of a robot or automated system. 2.E.02.02
- 3 Program a robot or automated system to perform several tasks. 2.E.02.03
- 4 Program a robot or automated system to solve a materials handling problem. 2.E.02.04
- 5 Design an automated feed system with sensors. 2.E.02.05
- 6 Design an interface that inspects, evaluates, and manages program parameters during the operation of the program. 2.E.02.06

3 Build and implement automated systems engineering designs. 2.E.03

- 1 Develop an end effector. 2.E.03.01
 - 2 Build a working model of a robot or automated system. 2.E.03.02
 - 3 Build drive systems used in robotics or automated system. 2.E.03.03
 - 4 Operate a CIM system utilizing appropriate safety precautions. 2.E.03.04
 - 5 Demonstrate how individual components work together to form a complete CIM system. 2.E.03.05
 - 6 Assemble and test individual component designs by integrating them into a complete model FMS. 2.E.03.06
 - 7 Run, test, evaluate, and redesign system operation. 2.E.03.07
 - 8 Build an automated feed system with sensors. 2.E.03.08
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**Civil
Engineering/Architecture
Demonstration, Design,
and Implementation 2.F**

- 1 Demonstrate civil engineering/architecture introductory knowledge. 2.F.01**
 - 1 Describe the importance of architecture and civil engineering and their evolution over time. 2.F.01.01
 - 2 Compare and contrast various architectural styles. 2.F.01.02
 - 3 Describe the components of and coordination required of an entire construction document set including: mechanical, electrical, plumbing, civil, structural and architectural drawings. 2.F.01.03
 - 4 Use an architectural or engineering scale to measure drawings. 2.F.01.04
 - 5 Identify various structural systems (i.e. steel frame, concrete frame, etc.) including foundation types. 2.F.01.05
 - 6 Explain surveying strategies and equipment use. 2.F.01.06
 - 7 Describe the importance of sustainable design. 2.F.01.07
 - 8 Identify and differentiate among the responsibilities of various members of a project team including the design (architect, engineers, etc.) and construction team (general contractor, subcontractors, etc.) members. 2.F.01.08
 - 9 Solve statics problems using computerized packages (e.g., MD Solids). 2.F.01.09
 - 10 Calculate stress and strain in simple parts. 2.F.01.10
 - 11 Plot a stress/strain diagram. 2.F.01.11
 - 12 Describe the parts of a stress/strain diagram. 2.F.01.12
 - 13 Perform moment of inertia calculations. 2.F.01.13
 - 14 Solve for stress, strain, and deflection in common beam shapes. 2.F.01.14
 - 15 Analyze, describe, and test basic beam deflection relationships: stress, strain, tension, compression, torsion, moments for common cross-sectional shapes and materials, using such techniques as finite element analysis (FEA). 2.F.01.15
 - 16 Construct free body diagrams; resolve forces into vector components; solve static equations; and calculate stress, strain, deflection, moment of inertia, linear and angular velocity and acceleration. 2.F.01.16

2 Explain and apply civil engineering/architectural principles and techniques, and use design tools and materials according to current industry and OSHA standards. 2.F.02

- 1 Create a site survey. 2.F.02.01
- 2 Conduct soil testing and analyze the results. 2.F.02.02
- 3 Analyze a site and determine the drainage requirements. 2.F.02.03
- 4 Design site grading including cut and fill volume calculations. 2.F.02.04
- 5 Create a commercial site design including parking, roads, and landscaping. 2.F.02.05
- 6 Apply building codes, regulations, and standards to a construction project. 2.F.02.06
- 7 Calculate dead, live, and environmental (snow, wind) loads on a structure. 2.F.02.07
- 8 Trace gravity loads through a structure from their point of application to the building's foundation. 2.F.02.08
- 9 Determine the tributary area of a particular structural element. 2.F.02.09
- 10 Design a simply supported beam including an analysis of shear, bending moment and deflection requirements. 2.F.02.10
- 11 Create a cost estimate for a construction project. 2.F.02.11
- 12 Perform heat loss calculations. 2.F.02.12
- 13 Apply sustainable design to a project. 2.F.02.13

3 Build and implement civil engineering/architecture designs. 2.F.03

- 1 Create a 3D computer model of both residential and commercial buildings. 2.F.03.01
- 2 Build a scale model of a building with a particular architectural style. 2.F.03.02
- 3 Build, test, and redesign a scale model of an engineering structure (e.g., building, bridge, etc.). 2.F.03.03
- 4 Create an as-built drawing set including plans, sections, and details. 2.F.03.04