Construction Technologies

Career Field Technical Content Standards

2019

Department of Education & Workforce

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Foreword

The Career Field Technical Content Standards serve as the curricular framework for Ohio's career-technical education pathway programs as outlined in Ohio Administrative Code 3301-61-03 (Criteria for Secondary Workforce Development Programs).

Career Field Technical Content Standards outline the knowledge and skills needed for success in careers across multiple pathways. Validated by Ohio business and industry representatives in conjunction with Ohio educators, these standards form the basis for developing educational programming in Ohio middle and secondary schools. The standards also serve as the framework for developing strong career pathways that connect secondary education with postsecondary education systems and the workplace.

This version of Career Field Technical Content Standards is intended to support the ongoing evolution of career technical education pathway programs. The standards tend to be somewhat broader than previous versions and are not repeated for individual pathways or occupational areas. The broader and non-duplicated statements are intended to capture the knowledge and skills that can be applied across any number of occupations in a pathway rather than focusing on the requirement of a single occupation. After all, the intent of a pathway program is to prepare a student for a range of educational and career opportunities following high school.

Pathway programs prepare students to combine broad knowledge, insight and understanding of business processes, academic attainment and workplace readiness with depth of knowledge and expertise in a technical area. Knowing that many careers will require some level of postsecondary education, the content standards also delineate the knowledge and skills necessary to seamlessly transition to postsecondary educational programs.

This document seeks to provide the basis for educational programming that will provide the employee with fundamental skill-sets that employers demand. This ensures that Ohio's workforce of tomorrow is competitive in a global environment. An environment that requires knowledge and skills can be applied in a broader context, aimed at innovation to support new products and services in an ever-changing economy.

In addition to the extensive engagement of secondary and postsecondary educators and business/industry professionals, development of these standards represents a collaborative effort of the following professional partners: the Ohio Department of Education's Office of Career-Technical Education; the Ohio Department of Higher Education Secondary Career-Technical Alignment Initiative.

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Philosophy and Principles for Implementation

Ohio Career Field Initiative

The overarching framework for Ohio career-technical education is outlined in the Ohio Revised Code and subsequent administrative rules, which specify career-technical programming based on 16 career fields. These 16 career fields provide the framework for an Ohio career field initiative that seeks to foster the educational shift necessary to respond to the needs of a rapidly changing global environment.

A career field is a "group of occupations and broad industries based on common characteristics" (see http://education.ohio.gov/Topics/Career-Tech). Career fields are the basis for developing both broad and specialized technical content standards that serve as a framework for curriculum, instruction, assessment, and program design to address the needs of an entire industry and business sector. Ohio's 16 career fields align with national efforts to broaden and integrate career-technical education with academic study and reflect the workforce needs of today and tomorrow. For today's students to be adequately prepared for tomorrow's workforce, they must have an education that:

- **Incorporates a broad, long-term conception of work in combination with the depth of specialization skills**
  Employees need a comprehensive understanding beyond a single occupation. Career-technical programming needs to be provided in a larger context, so students can generalize learning, make connections between education and work, and adapt to changes in their careers. Workplace knowledge and skills are needed to prepare employees for collaborating and problem solving while contributing to the broader business process.
- **Emphasizes the acquisition of strong academic knowledge and skills**
  Academic skills provide the foundation for career success. The integration of academic content standards with career field technical content standards help to contextualize learning for students that make English language arts, mathematics, social studies, and science relevant to students as a means to an important end—success at work and in life.
- **Facilitates high school to postsecondary transitions**
  Students need knowledge and skills for success in a variety of postsecondary options, which include apprenticeships, industry credentials through adult education, two- and four-year college degree programs, and graduate school.

Career Pathways

A key component of the Ohio Career Field Initiative is a career pathway, which is a clear articulated sequence of rigorous academic and career-technical coursework. Beginning as early as middle school, students are exposed to career planning with options such as postsecondary degrees, industry-recognized certificate, and/or licensure. The career pathway is developed, implemented and maintained in partnership among secondary and postsecondary education and business. Career pathways are available to all students and adult learners that lead to rewarding careers.

To effectively facilitate the transition from secondary to postsecondary education and a career, pathways should encompass:

1. Coursework in a chosen career field based on technical content standards;
2. Rigorous academics that meet Ohio's academic content standards and grade-level expectations;
3. Electives that relate to career objectives;
4. Instructional enhancements such as experiential and authentic learning opportunities (e.g., work-based learning, mentorships, internships) and career-technical student organization participation;
5. Opportunities for program and student certification and licensure;
6. Preparation for transition to further study that includes college readiness and opportunities to earn college credit while in high school;
7. Preparation for transition to employment with advancement opportunities;
8. Performance targets that include high school academic and technical testing and postsecondary placement requirements;
9. Various areas within an industry or encompass a function that crosses industry sectors;
10. The scope of opportunities in the related industry and available college programs;
11. Opportunities to prepare for a range of careers, including
    a. multiple employment opportunities after high school
    b. opportunities for students to enter and succeed in postsecondary and continuing education programs;
12. Transferable skills required for employment in the range of occupations aligned to the pathway; and
13. Opportunities to learn skills across the pathway as well as in specialized areas.

Structure and Format

The Career Field Technical Content Standards document contains a series of strands comprised of outcomes that each contain a set of competencies.

- A **strand** is a large content area under which multiple outcomes are organized, regardless of the pathway. It includes a title and a concise description with statements that capture multiple, broad areas of learner knowledge and skills expected across all outcomes in the strand. There are approximately 6 strands of content per career field. For example, Strand 1 Business Operations/21st Century Skills (employability skills, leadership and communications, business ethics and law, knowledge management and information technology, global environment, business literacy, entrepreneurship/entrepreneurs, operations management, financial management, sales and marketing and principles of business economics), is the same for all career-technical education career fields.
- An **outcome** is an overarching statement that summarizes the knowledge and skills described in a set of individual competencies to be learned by the end of the 12th grade. There are usually 5–15 outcomes within a strand, depending on the breadth of content to be addressed.
- A **competency** is a specific statement of essential knowledge or skill to be learned in the pathway program. There are usually 5–12 competencies under an outcome.

Each set of outcomes and competencies is included in one or more pathways in the career field. Outcomes and competencies form the basis for developing secondary courses, programs, instruction, and assessment. This provides the facilitation to transition from one educational level to the next and to the workplace. This supports career readiness and long-term career success by:

- Providing the basis for effective collaboration, teamwork, and communication across pathways;
- Laying the groundwork for successful transfer of knowledge and skills across pathways, thereby facilitating horizontal and vertical career success; and
- Equipping students and workers with the skills needed to transition to new and emerging careers throughout their lifetime.

All outcomes and competencies in the Career Field Technical Content Standards have been verified as essential by business and labor representatives within the specified pathways.

These essential outcomes and competencies specify industry-based knowledge or hands-on skills that are required by the end of 12th grade to be successful in a career pathway and on-going learning such as college, apprenticeships, and military opportunities.

Development of Construction Technologies Career Field Technical Content Standards

The process for the development of the Construction Technologies Career Field Technical Content Standards began in August 2018 and culminated in September 2019. Numerous business and industry representatives as well as secondary and postsecondary educators from across the state of Ohio took part in the formal development process. The following summarizes the various stages of the development process.

Research and Development

The engagement of subject matter experts, including educators, was critical to the completion of the draft revision of the document. Development was also informed by consulting the following sources of information:

- National Association of State Directors of Career Technical Education Consortium (NASDCTEc); Common Career Technical Core (CCTC) standards and Programs of Study;
- Industry-based certifications/standards;
    - National Center for Construction Education and Research (NCCER);
    - HVAC Excellence;
    - Air Conditioning Heating and Refrigeration Institute (ACRI);
- Ohio Home Builders Association (OHBA);
- Apprenticeship programs;
- SkillsUSA;
- Partnership for 21st Century Skills;
- Career-Technical Transfer Assurance Guides (CTAGs);
- University System of Ohio Academic Program Guide; and
- Ohio Industry Employment Projections Report, 2008-18.

Futuring/Advisory Panel

On August 13, 2018, the Construction Technologies futuring panel brought together key business and industry representatives from across the state to advise the Ohio Department of Education on trends impacting the Construction Technologies career field. The participants were asked to share their perceptions on changes in the workplace, employment trends, changes in technical skill requirements, needed workplace readiness skills and available industry-recognized standards and credentials. This feedback was used to develop and streamline the standards document into what is most demanded by the labor market.

Postsecondary Alignment

The goal of the Secondary Career-Technical Alignment Initiative (SCTAI) was to develop new statewide Career-Technical Assurance Guides (CTAGs) for secondary career-technical institutions. The partnership between the Ohio Department of Higher Education's CTAG development process and the Ohio Department of Education's Career Field Technical Content Standards resulted in tighter alignment between secondary career-technical and postsecondary content. This led to the development of pathways, which encouraged college enrollment and increased statewide postsecondary options for career-technical students. For more information on CTAGs and opportunities for statewide postsecondary articulated transfer credit, visit https://transfercredit.ohio.gov

Acknowledgements

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- Anne Skuce, Senior Associate Director, SCTAI, Ohio Department of Higher Education
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Those listed above provided vision and implementation support for the Construction Technologies Career Field Technical Content Standards and Ohio's Construction Technologies educational programs.

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Career Pathways Definitions

The Construction Technologies Career Field prepares students for careers in designing, planning, managing, building and maintaining commercial, industrial and residential structures and infrastructures. Students in the Construction Technologies career field may continue into registered apprenticeships or traditional postsecondary programs. Apprenticeship opportunities may be found at the Ohio State Apprenticeship Council website (http://jfs.ohio.gov/apprenticeship/index.stml).

Design

Design program areas will prepare students for careers dealing with construction design, facility maintenance, construction management and site safety and heavy equipment operations.

Careers for which this pathway prepares students include:

Architectural Designer
Civil Drafting Engineering
Site Manager
Facility Maintenance Technician/Manager
Heavy Equipment Operator
Interior Designer
Project Manager
Surveyor
Site Safety Coordinator

Postsecondary majors for which this pathway prepares students include:

Architectural Drafting
Building/Construction Site Management/Manager
Construction Management
Heavy/Industrial Maintenance Equipment Technologies Interior Design

Mechanical, Electrical, Plumbing

Mechanical, electrical and plumbing program areas will prepare students for careers in electrical, plumbing, sheet metal and environmental control installation and maintenance.

Careers for which this pathway prepares students include:

Electrician
Facility Maintenance Technician
HVAC Technician
Plumber
Power Line Technician
Sheet Metal Fabricator
Telecommunications Technician

Postsecondary majors for which this pathway prepares students include:

Building Construction Technology
Construction Trades
Electrical and Power Transmission Installation Installer
Electrical/Electronic Technology
Energy Management Technology

Environmental Engineering Management Technology
HVAC Technology
Pipefitter and Sprinkler Fitter Technology
Plumber
Sheet Metal Technology

Structural

Structural program areas will prepare students for careers in occupations related to Carpentry and Masonry construction and maintenance.

Careers for which this pathway prepares students include:

Brick, Block and Cement Mason
Carpenter
Drywall Technician
Flooring Specialist
General Contractor
Remodeler
Roofer

Postsecondary majors for which this pathway prepares students include:

Building Construction Technology
Cabinetmaking and Millwork
Construction Trades
Structural Engineering

Strand/Outcome Pathway Chart

An "X" indicates that the pathway applies to the outcome.

Strand/Outcome	Pathway		
	Design	Mechanical, Electrical, Plumbing	Structural
Strand 1: Business Operations/21st Century Skills page 2			
Outcome 1.1: Employability Skills	X	X	X
Outcome 1.2: Leadership and Communications	X	X	X
Outcome 1.3: Business Ethics and Law	X	X	X
Outcome 1.4: Knowledge Management and Information Technology	X	X	X
Outcome 1.5: Global Environment	X	X	X
Outcome 1.6: Business Literacy	X	X	X
Outcome 1.7: Entrepreneurship/Entrepreneurs	X	X	X
Outcome 1.8: Operations Management	X	X	X
Outcome 1.9: Financial Management	X	X	X
Outcome 1.10: Sales and Marketing	X	X	X
Outcome 1.11: Principles of Business Economics	X	X	X
Outcome 1.12: Cyber Hygiene	X	X	X
Strand 2: Safety, Tools, and Equipment page 13			
Outcome 2.1: Site Safety	X	X	X
Outcome 2.2: Personal Safety	X	X	X
Outcome 2.3: Equipment Operation	X	X	X
Outcome 2.4: Equipment and Machinery Preventative Maintenance	X	X	X
Strand 3: Structural Construction page 16			
Outcome 3.1: Brick, Block and Concrete	X		X
Outcome 3.2: Site Management	X	X	X
Outcome 3.3: Excavation	X		X
Outcome 3.4: Geographic Information Systems (GIS)	X		X
Outcome 3.5: Floor Framing			X
Outcome 3.6: Wall Framing			X
Outcome 3.7: Roof Framing and Finishing			X
Outcome 3.8: Exterior Finish Work	X		X
Outcome 3.9: Stairs		X	X

Strand/Outcome	Pathway		
	Design	Mechanical, Electrical, Plumbing	Structural
Outcome 3.10: Interior Finish Work	X		X
Outcome 3.11: Remodeling	X		X
Strand 4: Electrical page 22			
Outcome 4.1: Electrical Theory		X	X
Outcome 4.2: Circuits		X	X
Outcome 4.3: Codes and Regulations	X	X	
Outcome 4.4: Electrical Wiring		X	
Outcome 4.5: Motors and Power		X	
Outcome 4.6: Alternative Power and Renewable Energy Systems	X	X	X
Strand 5: Environmental Systems and Plumbing page 31			
Outcome 5.1: Refrigeration		X	
Outcome 5.2: Heating, Ventilation, Air Conditioning/Refrigeration (HVAC/R) Systems Installation		X	
Outcome 5.3: Service Maintenance	X	X	
Outcome 5.4: Energy Assessment	X	X	
Outcome 5.5: Boiler Systems	X	X	
Outcome 5.6: Sheet Metal		X	
Outcome 5.7: Drainage	X	X	
Outcome 5.8: Water Systems	X	X	
Outcome 5.9: Fuel Piping Systems	X	X	
Strand 6: Construction Management and Jobsite Maintenance page 33			
Outcome 6.1: Construction Math	X	X	X
Outcome 6.2: Construction Drawings	X	X	X
Outcome 6.3: Construction Estimating	X	X	X
Outcome 6.4: Construction Scheduling	X	X	
Outcome 6.5: Field Organization	X		X
Outcome 6.6: Building Maintenance	X		
Strand 7: Planning and Design page 37			
Outcome 7.1: Proposals	X		
Outcome 7.2: Community Planning	X	X	
Outcome 7.3: Drafting	X		
Total Outcomes by Pathway:	40	38	34
Total Outcomes:	51		

CONSTRUCTION TECHNOLOGIES

CAREER FIELD
TECHNICALCONTENT STANDARDS

STRANDS 1-7

Strand 1. Business Operations/21st Century Skills

Learners apply principles of economics, business management, marketing, and employability in an entrepreneur, manager, and employee role to the leadership, planning, developing, and analyzing of business enterprises related to the career field.

Outcome 1.1. Employability Skills

Develop career awareness and employability skills (e.g., face-to-face, online) needed for gaining and maintaining employment in diverse business settings.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating	Competencies	
N/R	1.1.1.	Identify the knowledge, skills, and abilities necessary to succeed in careers.
	1.1.2.	Identify the scope of career opportunities and the requirements for education, training, certification, licensure, and experience.
	1.1.3.	Develop a career plan that reflects career interests, pathways, and secondary and postsecondary options.
	1.1.4.	Describe the role and function of professional organizations, industry associations, and organized labor and use networking techniques to develop and maintain professional relationships.
	1.1.5.	Develop strategies for self-promotion in the hiring process (e.g., filling out job applications, resumé writing, interviewing skills, portfolio development).
	1.1.6.	Explain the importance of work ethic, accountability, and responsibility and demonstrate associated behaviors in fulfilling personal, community, and workplace roles.
	1.1.7.	Apply problem-solving and critical-thinking skills to work-related issues when making decisions and formulating solutions.
	1.1.8.	Identify the correlation between emotions, behavior, and appearance and manage those to establish and maintain professionalism.
	1.1.9.	Give and receive constructive feedback to improve work habits.
	1.1.10.	Adapt personal coping skills to adjust to taxing workplace demands.
	1.1.11.	Recognize different cultural beliefs and practices in the workplace and demonstrate respect for them.
	1.1.12.	Identify healthy lifestyles that reduce the risk of chronic disease, unsafe habits, and abusive behavior.

Outcome 1.2. Leadership and Communications

Process, maintain, evaluate, and disseminate information in a business. Develop leadership and team building to promote collaboration.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating	Competencies	
N/R	1.2.1.	Extract relevant, valid information from materials and cite sources of information.
	1.2.2.	Deliver formal and informal presentations.
	1.2.3.	Identify and use verbal, nonverbal, and active listening skills to communicate effectively.
	1.2.4.	Use negotiation and conflict-resolution skills to reach solutions.
	1.2.5.	Communicate information (e.g., directions, ideas, vision, workplace expectations) for an intended audience and purpose.
	1.2.6.	Use proper grammar and expression in all aspects of communication.
	1.2.7.	Use problem-solving and consensus-building techniques to draw conclusions and determine next steps.
	1.2.8.	Identify the strengths, weaknesses, and characteristics of leadership styles that influence internal and external workplace relationships.
	1.2.9.	Identify advantages and disadvantages involving digital and/or electronic communications (e.g., common content for large audience, control of tone, speed, cost, lack of non-verbal cues, potential for forwarding information, longevity).
	1.2.10.	Use interpersonal skills to provide group leadership, promote collaboration, and work in a team.
	1.2.11.	Write professional correspondence, documents, job applications, and resumés.
	1.2.12.	Use technical writing skills to complete forms and create reports.
	1.2.13.	Identify stakeholders and solicit their opinions.
	1.2.14.	Use motivational strategies to accomplish goals.

Outcome 1.3. Business Ethics and Law

Analyze how professional, ethical, and legal behavior contributes to continuous improvement in organizational performance and regulatory compliance.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating	Competencies	
N/R	1.3.1.	Analyze how regulatory compliance affects business operations and organizational performance.
	1.3.2.	Follow protocols and practices necessary to maintain a clean, safe, and healthy work environment.
	1.3.3.	Use ethical character traits consistent with workplace standards (e.g., honesty, personal integrity, compassion, justice).
	1.3.4.	Identify how federal and state consumer protection laws affect products and services.
	1.3.5.	Access and implement safety compliance measures (e.g., quality assurance information, safety data sheets [SDSs], product safety data sheets [PSDSs], United States Environmental Protection Agency [EPA], United States Occupational Safety and Health Administration [OSHA]) that contribute to the continuous improvement of the organization.
	1.3.6.	Identify deceptive practices (e.g., bait and switch, identity theft, unlawful door-to-door sales, deceptive service estimates, fraudulent misrepresentations) and their overall impact on organizational performance.
	1.3.7.	Identify the labor laws that affect employment and the consequences of noncompliance for both employee and employer (e.g., harassment, labor, employment, employment interview, testing, minor labor laws, Americans with Disabilities Act, Fair Labor Standards Acts, Equal Employment Opportunity Commission [EEOC]).
	1.3.8.	Verify compliance with computer and intellectual property laws and regulations.
	1.3.9.	Identify potential conflicts of interest (e.g., personal gain, project bidding) between personal, organizational, and professional ethical standards.

Outcome 1.4. Knowledge Management and Information Technology

Demonstrate current and emerging strategies and technologies used to collect, analyze, record, and share information in business operations.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating	Competencies	
N/R	1.4.1.	Use office equipment to communicate (e.g., phone, radio equipment, fax machine, scanner, public address systems).
	1.4.2.	Select and use software applications to locate, record, analyze, and present information (e.g., word processing, e-mail, spreadsheet, databases, presentation, Internet search engines).
	1.4.3.	Verify compliance with security rules, regulations, and codes (e.g., property, privacy, access, accuracy issues, client and patient record confidentiality) pertaining to technology specific to the industry pathway.
	1.4.4.	Use system hardware to support software applications.
	1.4.5.	Use information technology tools to maintain, secure, and monitor business records.
	1.4.6.	Use an electronic database to access and create business and technical information.
	1.4.7.	Use personal information management and productivity applications to optimize assigned tasks (e.g., lists, calendars, address books).
	1.4.8.	Use electronic media to communicate and follow network etiquette guidelines.

Outcome 1.5. Global Environment

Evaluate how beliefs, values, attitudes, and behaviors influence organizational strategies and goals.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating	Competencies	
N/R	1.5.1.	Describe how cultural understanding, cultural intelligence skills, and continual awareness are interdependent.
	1.5.2.	Describe how cultural intelligence skills influence the overall success and survival of an organization.
	1.5.3.	Use cultural intelligence to interact with individuals from diverse cultural settings.
	1.5.4.	Recognize barriers in cross-cultural relationships and implement behavioral adjustments.
	1.5.5.	Recognize the ways in which bias and discrimination may influence productivity and profitability.
	1.5.6.	Analyze work tasks for understanding and interpretation from a different cultural perspective.
	1.5.7.	Use intercultural communication skills to exchange ideas and create meaning.
	1.5.8.	Identify how multicultural teaming and globalization can foster development of new and improved products and services and recognition of new opportunities.

Outcome 1.6. Business Literacy

Develop foundational skills and knowledge in entrepreneurship, financial literacy, and business operations.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating	Competencies	
N/R	1.6.1.	Identify business opportunities.
	1.6.2.	Assess the reality of becoming an entrepreneur, including advantages and disadvantages (e.g., risk versus reward, reasons for success and failure).
	1.6.3.	Explain the importance of planning your business.
	1.6.4.	Identify types of businesses, ownership, and entities (i.e., individual proprietorships, partnerships, corporations, cooperatives, public, private, profit, not-for-profit).
	1.6.5.	Describe organizational structure, chain of command, the roles and responsibilities of the organizational departments, and interdepartmental interactions.
	1.6.6.	Identify the target market served by the organization, the niche that the organization fills, and an outlook of the industry.
	1.6.7.	Identify the effect of supply and demand on products and services.
	1.6.8.	Identify the features and benefits that make an organization's product or service competitive.
	1.6.9.	Explain how the performance of an employee, a department, and an organization is assessed.
	1.6.10.	Describe the impact of globalization on an enterprise or organization.
	1.6.11.	Describe how all business activities of an organization work within the parameters of a budget.
	1.6.12.	Describe classifications of employee benefits, rights, deductions, and compensations.

Outcome 1.7. Entrepreneurship/Entrepreneurs

Analyze the environment in which a business operates and the economic factors and opportunities associated with self-employment.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating	Competencies	
N/R	1.7.1.	Compare and contrast the four types of business ownership (i.e., individual proprietorships, partnerships, corporations, cooperatives).
	1.7.2.	Explain the role of profit as the incentive to entrepreneurs in a market economy.
	1.7.3.	Identify the factors that contribute to the success and failure of entrepreneurial ventures.
	1.7.4.	Assess the roles of nonprofit and for-profit businesses.
	1.7.5.	Develop a business plan.
	1.7.6.	Describe life cycles of an entrepreneurial business and an entrepreneur.
	1.7.7.	Create a list of personal strengths, weaknesses, skills, and abilities needed to be successful as an entrepreneur.
	1.7.8.	Explain pathways used to become an entrepreneur.
	1.7.9.	Conduct a self-assessment to determine entrepreneurial potential.
	1.7.10.	Describe techniques for obtaining experience (e.g., apprenticeship, co-operative [co-op] education, work placement, internship, job shadowing) related to an entrepreneurial objective.
	1.7.11.	Identify initial steps in establishing a business (e.g., limited liability company [LLC], tax ID, permits, insurance, licensing).
	1.7.12.	Identify resources available to entrepreneurs (e.g., Small Business Administration, mentors, information resources, educational opportunities).
	1.7.13.	Protect intellectual property and knowledge (e.g., copyright, patent, trademark, trade secrets, processes).

Outcome 1.8. Operations Management

Plan, organize, and monitor an organization or department to maximize contribution to organizational goals and objectives.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating	Competencies	
N/R	1.8.1.	Forecast future resources and budgetary needs using financial documents (e.g., balance sheet, demand forecasting, financial ratios).
	1.8.2.	Select and organize resources to develop a product or a service.
	1.8.3.	Analyze the performance of organizational activities and reallocate resources to achieve established goals.
	1.8.4.	Identify alternative actions to take when goals are not met (e.g., changing goals, changing strategies, efficiencies).
	1.8.5.	Use inventory and control systems to purchase materials, supplies, and equipment (e.g., Last In, First Out [LIFO]; First In, First Out [FIFO]; Just in Time [JIT]; LEAN).
	1.8.6.	Identify the advantages and disadvantages of carrying cost and Just-in-Time (JIT) production systems and the effects of maintaining inventory (e.g., perishable, shrinkage, insurance) on profitability.
	1.8.7.	Collect information and feedback to help assess the organization's strategic planning and policymaking processes.
	1.8.8.	Identify routine activities for maintaining business facilities and equipment.
	1.8.9.	Develop a budget that reflects the strategies and goals of the organization.
	1.8.10.	Analyze how business management and environmental management systems (e.g., health, safety) contribute to continuous improvement and sustainability.

Outcome 1.9. Financial Management

Use financial tools, strategies, and systems to develop, monitor, and control the use of financial resources to ensure personal and business financial well-being.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating Con etencies

1.9. . Create, analyze, and interpret financial documents (e.g., budgets, income statements).
1.9. . Identify tax obligations.
1.9. . Review and summarize savings, investment strategies, and purchasing options (e.g., cash, lease, finance, stocks, bonds).
1.9. . Identify credit types and their uses in order to establish credit.
1.9. . Identify ways to avoid or correct debt problems.
1.9. . Explain how credit ratings and the criteria lenders use to evaluate repayment capacity affect access to loans.
1.9. . Review and summarize categories (types) of insurance and identify how insurances can reduce financial risk.
1.9. . Identify income sources and expenditures.
1.9. . Compare and contrast different banking services available through financial institutions.
1.9. 0. Identify the role of depreciation in tax planning and liability.

Outcome 1.10. Sales and Marketing

Manage pricing, place, promotion, packaging, positioning, and public relations to improve quality customer service.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating	Competencies	
N/R	1.10.1.	Identify how the roles of sales, advertising, and public relations contribute to a company's brand.
	1.10.2.	Determine the customer's needs and identify solutions.
	1.10.3.	Communicate features, benefits, and warranties of a product or service to the customer.
	1.10.4.	Identify the company policies and procedures for initiating product and service improvements.
	1.10.5.	Monitor customer expectations and determine product/service satisfaction by using measurement tools.
	1.10.6.	Discuss the importance of correct pricing to support a product's or service's positioning in the marketing mix.
	1.10.7.	Describe the importance and diversity of distribution channels (i.e., direct, indirect) to sell a product.
	1.10.8.	Use promotional techniques to maximize sales revenues (e.g., advertising, sales promotions, publicity, public relations).
	1.10.9.	Describe how product mix (e.g., product line, product items) maximizes sales revenues, market, share, and profit margin.
	1.10.10.	Demonstrate sales techniques.

Outcome 1.11. Principles of Business Economics

Examine and employ economic principles, concepts, and policies to accomplish organizational goals and objectives.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating	Competencies	
N/R	1.11.1.	Identify the economic principles that guide geographic location of an industry's facilities (e.g., relative scarcity, price, quantity of products and services).
	1.11.2.	Identify the difference between monetary and nonmonetary incentives and explain how changes in incentives cause changes in behavior.
	1.11.3.	Use economic indicators to identify economic trends and conditions (e.g., inflation, interest rate fluctuations, unemployment rates).
	1.11.4.	Determine how the quality, quantity, and pricing of goods and services are affected by domestic and international competition in a market economy.
	1.11.5.	Analyze factors that affect currency and exchange rates.
	1.11.6.	Explain how financial markets and government policies influence interest rates (credit ratings/debt ceiling), trade deficits, and unemployment.
	1.11.7.	Describe how economic performance and culture are interdependent.
	1.11.8.	Identify the relationships between economy, society, and environment that lead to sustainability.
	1.11.9.	Describe how laws and regulations influence domestic and international trade.

Outcome 1.12. Cyber Hygiene

Apply digital information security principles to keep information secure.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating	Competencies	
N/R	1.12.1.	Identify the purpose and practices of Cyber Hygiene.
	1.12.2.	Differentiate between appropriate and inappropriate information.
	1.12.3.	Interpret security policies through job specific training and training updates.
	1.12.4.	Apply secure password behavior.
	1.12.5.	Apply physical and virtual situational awareness (e.g., clean desk policies, shoulder surfing, social engineering, tailgating).

Strand 2. Safety, Tools, and Equipment

Learners apply principles of protection, prevent and mitigation to create and maintain safe working conditions at construction sites. Knowledge and skills may be applied in all aspects of personal site safety to meet all applicable standards.

Outcome 2.1. Site Safety

Handle materials, prevent accidents and mitigate hazards.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating	Competencies	
1	2.1.1.	Use Occupational Safety and Health Administration (OSHA)-defined procedures for identifying employer and employee responsibilities, working in confined spaces, managing worker safety programs, using ground fault circuit interrupters (GFCIs), maintaining clearance and boundaries and labeling.
1	2.1.2.	Identify and rectify or mitigate construction hazards (e.g., thresholds, slippery surfaces, lighting and workplace clutter).
1	2.1.3.	Identify and apply load factors for constructing scaffolding, railings, ladders and temporary structures.
1	2.1.4.	Apply inspection, rejection criteria, hitch configurations and load-handling practices to slings and rigging hardware.
1	2.1.5.	Demonstrate the proper use of American National Standards Institute (ANSI) hand signals.
2	2.1.6.	Identify the source of electrical hazards and use shutdown and established lock-out/tag-out procedures.
2	2.1.7.	Identify procedures for the handling, storage and disposal of hazardous materials.
1	2.1.8.	Identify the location of emergency flush showers, eyewash fountains, Safety Data Sheets (SDSs), fire alarms and exits.
1	2.1.9.	Select and operate fire extinguishers based on the class of fire.
2	2.1.10.	Create a hazardous materials safety plan (e.g., liquid and airborne materials).
2	2.1.11.	Describe the interactions of incompatible substances when measuring and mixing chemicals.

Outcome 2.2. Personal Safety

Practice personal safety in construction.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating	Competencies	
1	2.2.1.	Interpret personal safety rights according to the employee Right-to-Know plan.
1	2.2.2.	Describe how working under the influence (e.g., drugs, alcohol and stimulants/caffeine) increases the risk of accident, lowers productivity, raises insurance costs, and reduces profits.
2	2.2.3.	Select, use, store, maintain and dispose of personal protective equipment (PPE) appropriate to job tasks, conditions and materials.
1	2.2.4.	Identify workplace risk factors associated with lifting, operating and moving heavy objects and establish an ergonomics process.
2	2.2.5.	Identify, inspect and use safety equipment appropriate for the task.
2	2.2.6.	Demonstrate first aid and cardiopulmonary resuscitation (CPR).
1	2.2.7.	Identify and describe hazards associated with using electronic devices on the job site.
1	2.2.8.	Identify and describe hazards associated with improper clothing and poor hygiene.
1	2.2.9.	Describe trenching and excavation hazards (e.g. soil types, cave in, utilities, underground obstacles).
1	2.2.10.	Describe the process for identifying and locating existing site utilities.

Outcome 2.3. Equipment Operation

Operate equipment used to move materials, earth and other heavy materials.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating	Competencies	
2	2.3.1.	Select the equipment and attachments needed to complete the task.
1	2.3.2.	Follow the manufacturer' recommendations for safety, maintenance, limitations and use.
1	2.3.3.	Perform pre- and post-operation inspections and adjustments and report malfunctions.
2	2.3.4.	Operate levers, pedals or valves to activate power equipment.
1	2.3.5.	Drive and maneuver equipment with and without trailers.

Outcome 2.4. Equipment and Machinery Preventative Maintenance

Clean, maintain and perform planned preventative maintenance (PPM) on equipment and machinery.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating	Competencies	
1	2.4.1.	Lubricate machinery and equipment.
1	2.4.2.	Ensure the presence and functionality of safety systems and hardware.
1	2.4.3.	Service electrical systems (e.g., fuses, bulbs).
2	2.4.4.	Perform machine adjustments (e.g., belts, drive chains).
1	2.4.5.	Service filtration systems.
1	2.4.6.	Identify, select and maintain fluid levels.
1	2.4.7.	Maintain instrument, machinery and equipment cleanliness, appearance and safety devices.
1	2.4.8.	Inspect and maintain fluid conveyance and storage components (e.g., hoses, lines, valves, nozzles).
1	2.4.9.	Inspect and maintain tooling and implements.
1	2.4.10.	Document and log equipment maintenance records.

Strand 3. Structural Construction

Learners apply principles of architectural engineering to erect residential, commercial and industrial buildings. Knowledge and skills may be applied in constructing footings and foundations; framing floors, walls, ceilings, roofs and stairs; completing exterior and interior finishes; and repairing, restoring or remodeling existing structures.

Outcome 3.1 Brick, Block and Concrete

Mix and pour concrete and lay brick and block.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X		X

DOK Rating	Competencies	
1	3.1.1.	Complete layout calculations.
1	3.1.2.	Set grades and establish benchmark.
2	3.1.3.	Construct foundations, footings and retaining walls.
2	3.1.4.	Lay brick and block (Concrete Masonry Units) with mortar.
2	3.1.5.	Lay out and erect forms and stair forms and install reinforcing material.
2	3.1.6.	Lay out and install anchor bolts in concrete.
2	3.1.7.	Install and finish mortar joints.
2	3.1.8.	Cast and finish concrete.
1	3.1.9.	Demonstrate knowledge of specialty finishes to concrete.
2	3.1.10.	Level base material.
2	3.1.11.	Compare types of foundation and materials (e.g., brick, block, poured).

Outcome 3.2. Site Management

Analyze site management operations.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating	Competencies	
1	3.2.1.	Identify topographical and existing features of areas (i.e., property lines, utilities, streets, setbacks) on survey maps (parcel map, survey plat).
2	3.2.2.	Interpret features of a site plan.
2	3.2.3.	Apply conventional engineering and field measurement processes to survey for site development.
1	3.2.4.	Identify and apply relevant building codes.

Outcome 3.3. Excavation

Perform excavation activities from clearing and grubbing to finish grading in accordance with excavation specifications on prints and in local building codes.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X		X

DOK Rating	Competencies	
1	3.3.1.	Describe excavation, trenching, and shoring designs.
1	3.3.2.	Compare the effects of soil properties, profiles and types on construction and describe fill placement processes (e.g., lifts, geomat fabrics, compaction, density, moisture content).
2	3.3.3.	Collect samples and explain the environmental impact of contaminated soil and water on the worksite.
1	3.3.4.	Explain disposal procedures for contaminated soil, water and waste.
1	3.3.5.	Describe procedures to control water runoff and drainage.
1	3.3.6.	Identify the actual location and elevation and determine variance.
1	3.3.7.	Check alignment and elevations.
2	3.3.8.	Clear and grub land to prepare site for grading.
1	3.3.9.	Explain the types of grade (e.g., subgrade, finished grade).
1	3.3.10.	Identify the types of stakes and describe their functions.
1	3.3.11.	Describe fill materials, their appropriateness and their functions.
2	3.3.12.	Lay out stakes in sequence and set grade.

Outcome 3.4. Geographic Information Systems (GIS)

Employ GIS computer applications to interpret data, maps and land use.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X		X

DOK Rating	Competencies	
1	3.4.1.	Interpret and evaluate the accuracy of digital imagery and aerial photography.
1	3.4.2.	Explain map projections and the use of scales.
1	3.4.3.	Describe GIS data structures (e.g., vector, grid, triangulated irregular network [TIN]).
1	3.4.4.	Explain digital elevation methods (e.g., digital elevation model [DEM], global positioning system [GPS]).
2	3.4.5.	Interpret spatial interpolation and two- and three-dimensional functional spatial analyses.
2	3.4.6.	Demonstrate ranging methods.
3	3.4.7.	Identify sources of errors in GIS and formulate corrections and solutions.
1	3.4.8.	Determine one's position on the earth using GPS.
2	3.4.9.	Integrate GPS data into GIS applications.

Outcome 3.5. Floor Framing

Install floor framing systems.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
		X

DOK Rating	Competencies	
1	3.5.1.	Identify, describe, and assemble materials for floor framing.
2	3.5.2.	Construct and install sills and sill sealer.
2	3.5.3.	Erect girders, beams and columns.
2	3.5.4.	Lay out, cut and install floor joists.
2	3.5.5.	Frame floor openings.
2	3.5.6.	Install bridging (e.g., wood, metal).
2	3.5.7.	Install subflooring using adhesives and fasteners.

Outcome 3.6. Wall Framing

Construct wall and ceiling framing.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
		X

DOK Rating	Competencies	
1	3.6.1	Identify platform and balloon framing.
1	3.6.2.	Lay out walls and rough openings.
2	3.6.3.	Compare and contrast metal and wood framing.
2	3.6.4.	Locate partitions, determine stud layout and strike wall lines.
1	3.6.5.	Describe wall framing techniques used in masonry construction.
2	3.6.6.	Cut and assemble wood and metal wall framing components (e.g., corner posts, T-posts, door openings, window openings, headers, cripples, king studs, trimmers, common studs, blocking).
2	3.6.7.	Erect and plumb partitions and walls with top and bottom plates.
2	3.6.8.	Brace exterior walls and install wind bracing.
2	3.6.9.	Install exterior wall sheathing and house wrap.
2	3.6.10.	Lay out, cut, and install ceiling joists and bracing.

Outcome 3.7. Roof Framing and Finishing

Construct and finish roof.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
		X

DOK Rating	Competencies	
1	3.7.1.	Compare roof types and materials.
1	3.7.2.	Identify, describe and assemble materials for roof framing.
2	3.7.3.	Lay out, cut and install ridge boards and common rafters.
2	3.7.4.	Lay out, cut and install hip rafters and install valley rafters and jack rafters.
2	3.7.5.	Lay out, cut and install gable-end studs and lookouts.
2	3.7.6.	Frame roof openings, dormers and chimney saddles.
2	3.7.7.	Install roof sheathing.
2	3.7.8.	Install prefabricated roof trusses with required hardware.
2	3.7.9.	Install drip edges, eaves flashing and roof vents.
2	3.7.10.	Install underlayment (ice and water barriers) and shingles.
2	3.7.11.	Lay out and install shingles and other roof finishes (e.g., fiberglass, asphalt, wood, valley material, felt paper, starter strip, hip and ridge caps).

Outcome 3.8. Exterior Finish Work

Complete exterior finish.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X		X

DOK Rating	Competencies	
1	3.8.1.	Compare types and characteristics of doors and windows.
1	3.8.2.	Identify, describe, and assemble materials for exterior finishing.
2	3.8.3.	Install exterior door and window units and hardware.
2	3.8.4.	Install weather stripping and apply caulking and sealant.
2	3.8.5.	Install fascia and soffits with backing.
2	3.8.6.	Cut and install molding and frieze board.
2	3.8.7.	Case exterior openings.
2	3.8.8.	Install exterior siding, covering, or finishes.
2	3.8.9.	Install exterior trim accessories (e.g., gutters, downspouts, louvers, shutters, posts, railings, decorative moldings).
2	3.8.10.	Install draft stopping.

Outcome 3.9. Stairs

Construct stairs.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X		X

DOK Rating	Competencies	
1	3.9.1.	Describe stairway types and their components.
2	3.9.2.	Calculate rise and run and design stairway risers, treads, carriage, stringers and clearances.
2	3.9.3.	Lay out, cut, and install stair components.
1	3.9.4.	Install stair finish trim components (e.g., skirt boards, handrails, balusters, newels, volutes, balustrade systems).
1	3.9.5.	Install prefabricated stairs and drop-down stair units (e.g., attic stairs).

Outcome 3.10. Interior Finish Work

Complete interior finish for residential, industrial and commercial facilities.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X		X

DOK Rating	Competencies	
1	3.10.1.	Describe the different types and characteristics of drywall and finishing materials.
2	3.10.2.	Lay out the drywall installation and nail or screw pattern and install drywall and corner accessories.
1	3.10.3.	Describe the effects insulation, vapor barriers and ventilation can have on controlling moisture.
2	3.10.4.	Install insulation and vapor barriers for wall and ceiling finishes.
2	3.10.5.	Install drywall board.
2	3.10.6.	Finish drywall board.
2	3.10.7.	Lay out and install alternative methods of ceiling (e.g. acoustic, suspended).
2	3.10.8.	Prepare subfloor, install building paper and cut and install underlayment.
1	3.10.9.	Lay out and install finished flooring (e.g., vinyl, carpet, wood, ceramic).
2	3.10.10.	Install door units (e.g., prehung, double hung, folding, sliding) and door hardware.
2	3.10.11.	Install interior door and window trim (e.g., stools, sills, jamb extensions, casing, mullions, aprons).
2	3.10.12.	Apply finish coatings (e.g., paint, stains, varnishes, texturing, wallpaper).

2	3.10.13.	Install baseboard and moldings (e.g., standard, crown, built-up moldings).
2	3.10.14.	Install cabinetry, shelving and related hardware.

Outcome 3.11. Remodeling

Repair, restore, or remodel existing structures.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X		X

DOK Rating	Competencies	
3	3.11.1.	Identify customer needs and develop a plan for a remodeling or restoration project.
3	3.11.2.	Identify damage, diagnose cause of damage and plain repair.
3	3.11.3.	Diagnose problems and plan deconstruction and preparation for repairs and/or restoration.
2	3.11.4.	Integrate new construction into existing structure.
2	3.11.5.	Match materials selected to the original structure.
4	3.11.6.	Design and construct temporary bracing and shoring and install safety and security devices during construction.

Strand 4. Electrical

Learners apply principles of electricity and knowledge of building codes to construct systems to generate and deliver power in residential, commercial and industrial applications. Knowledge and skill may be applied to rough-in and finish wiring, motors and power wiring, specialized low-voltage systems, alternative power systems, power transmission, plant operations and coal equipment.

Outcome 4.1. Electrical Theory

Summarize electrical principles and theories.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
	X	X

DOK Rating	Competencies	
1	4.1.1.	Describe atomic structure and its relationship to electricity.
2	4.1.2.	Compare the relationship between electrical and electromagnetic effect.
1	4.1.3.	Identify methods of producing electrical current.
1	4.1.4.	Describe the differences between alternating current (AC) and direct current (DC).
2	4.1.5.	Compare conductors and insulators.
2	4.1.6.	Describe the relationships between voltage, current, resistance and power in circuits.
1	4.1.7.	Calculate voltage, current, resistance, impedance and power in circuits using Ohm's Law, Kirchhoff's Law and Watt's Law.

Outcome 4.2. Circuits

Analyze and evaluate direct current (DC) circuits and alternating current (AC) circuits.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
	X	X

DOK Rating	Competencies	
1	4.2.1.	Identify electrical, electromechanical and solid state controls.
2	4.2.2.	Describe the purpose of and common methods used for grounding and bonding.
3	4.2.3.	Analyze wiring schematics and diagrams to troubleshoot circuits.
1	4.2.4.	Explain the use of series, parallel and series-parallel circuits.
3	4.2.5.	Construct and test series, parallel and series-parallel circuits.
1	4.2.6.	Determine voltage, current, frequency and phase.
1	4.2.7.	Identify common types and uses of transformers.
4	4.2.8.	Calculate service load demands and branch circuit load demands.
2	4.2.9.	Identify types of capacitors and common usages for each.
3	4.2.10.	Identify methods of varying capacitance.
1	4.2.11.	Identify types of inductors and explain the purposes of different core materials.
2	4.2.12.	Identify the characteristics of inductors and capacitors in series and parallel circuits.
1	4.2.13.	Calculate true power, apparent power, reactive power and power factor.

Outcome 4.3. Codes and Regulations

Explain and apply the National Electrical Code (NEC) and other building codes.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	

DOK Rating	Competencies	
1	4.3.1.	Describe the role of Nationally Recognized Testing Laboratories (e.g. Underwriters Laboratory (UL), Canadian Standards Association (CSA) and Intertek Testing Service/Edison Testing Laboratory (ITS/ETL)).
2	4.3.2.	Locate and apply the information in articles of the NEC and other relevant codes and explain how they impact job requirements (e.g., service conductors, feeders, branch circuits, overload protection, grounding and bonding requirements, low voltage).
2	4.3.3.	Utilize National Fire Protection Association (NFPA) procedures for NFPA 70E-arc flash boundaries, current-limiting fuses, live work power permits, electrically safe work conditions, emergency worker safety programs, scheduling, energized circuits and training.

Outcome 4.4. Electrical Wiring

Install above and in-ground wiring in residential, commercial and industrial settings.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
	X	

DOK Rating	Competencies	
3	4.4.1.	Select materials and lay out rough-in wiring runs according to specifications, drawings and code requirements.
2	4.4.2.	Identify and install fasteners, anchors, and fire stop systems.
2	4.4.3.	Locate and mount electrical boxes in exterior and interior applications.
2	4.4.4.	Verify the location of and install service entrance systems.
2	4.4.5.	Install service panels, meter apparatus, grounding electrode systems, subpanels and over current protective devices.
1	4.4.6.	Identify and label a panel directory to reflect devices and circuits installed on each circuit.
2	4.4.7.	Lay out and install conduit or cable runs, raceways and cable systems (e.g., electrical metallic tubing [EMT], galvanized rigid conduit [GRC], intermediate metal conduit [IMC], polyvinyl chloride [PVC], electrical nonmetallic tubing [ENT or ENMT], armored cable [AC], metal clad cable [MC]).
2	4.4.8.	Install rough-in wiring following specifications, drawings and code requirements.
3 as written – 2 if service	4.4.9.	Install, service, and troubleshoot low-voltage systems (e.g., communication systems, telephone systems, control systems, lighting systems, security systems, fire alarm systems).
2	4.4.10.	Install lighting fixtures, wiring devices and covers.
2	4.4.11.	Install equipment grounding and bonding systems.
2	4.4.12.	Make conductor terminations.
2	4.4.13.	Connect electrical appliances and equipment in accordance with NEC and manufacturer's instructions.
3	4.4.14.	Check and test installation.

Outcome 4.5. Motors and Power

Install motors and power wiring in accordance with the National Electrical Code (NEC).

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
	X	

DOK Rating	Competencies	
1	4.5.1	Identify types and components of single-phase, split-phase and three-phase motors.
2	4.5.2.	Calculate the branch circuit size of the motor based on nameplate information and specifications.

2	4.5.3.	Determine motor rotation needed for the installed load and explain the process for reversing rotation (i.e., three-phase, single-phase).
3	4.5.4.	Interpret schematics and control diagrams for building a motor circuit.
3	4.5.5.	Wire single-phase, split-phase and three-phase circuits and install motor control devices (i.e., contactors, starters, variable frequency and motor speed controls).
1	4.5.6.	Explain the starting sequence of motor components within a given circuit.
3	4.5.7.	Troubleshoot and repair motor and starting systems to verify operation according to schematics and control diagrams.
2	4.5.8.	Describe how programmable controllers can be used in single-phase, split-phase and three-phase circuits.

Outcome 4.6. Alternative Power and Renewable Energy Systems

Describe specialized power systems and components.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating	Competencies	
2	4.6.1.	Compare renewable energy systems.
1	4.6.2.	Identify and describe the functions of standby power systems (i.e., generator, uninterrupted power supplies [UPS] systems).
1	4.6.3.	Identify and describe the functions of electric storage systems.
2	4.6.4.	Describe battery maintenance functions (e.g., cleaning, checking electrolyte quality and level and battery status) and disposal methods.

Strand 5. Environmental Systems and Plumbing

Learners apply principles of physics and thermodynamics to install and maintain heating, ventilation and air conditioning (HVAC) and plumbing systems in residential, commercial, industrial, and utility applications.

Outcome 5.1. Refrigeration

Apply physical principles of refrigeration to the installation and maintenance of heating, ventilation and air conditioning (HVAC) systems.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
	X	

DOK Rating	Competencies	
2	5.1.1.	Record, analyze, and interpret temperature and pressure measurements and their relationship.
1	5.1.2.	Describe heat, heat transfer, energy and energy conversion.
1	5.1.3.	Differentiate between sensible, latent and total heat.
1	5.1.4.	Describe the thermodynamic cycle in the refrigeration process.
2	5.1.5.	Compare the functions of evaporators, condensers, compressors and metering devices of the basic refrigeration cycle.
2	5.1.6.	Compare the characteristics of refrigerants.
2	5.1.7.	Describe, calculate, and record superheating and subcooling.
2	5.1.8.	Calculate and record the saturation temperature of a refrigerant.
3	5.1.9.	Measure, calculate and set airflow (e.g., Cubic Feet per Minute and British Thermal Unit (BTU).

Outcome 5.2. Heating, Ventilation, Air Conditioning/Refrigeration (HVAC/R) Systems Installation

Install refrigeration, air conditioning, and heating systems.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
	X	

DOK Rating	Competencies	
1	5.2.1.	Identify the basic components of a self-contained air conditioning unit.
2	5.2.2.	Identify and install a central air conditioning system.
1	5.2.3.	Identify and install an air-to-air heat pump.
1	5.2.4.	Identify and install a refrigeration condensing unit with a remove evaporator.
1	5.2.5.	Identify and explain the installation of natural gas, propane gas, electric and oil heating units.
1	5.2.6.	Identify and install natural gas, propane gas, electric and oil heating units.

Outcome 5.3. Service Maintenance

Perform service maintenance (SM) and repair on environmental controls technology equipment (e.g., electric heating equipment, air handler, air filtration equipment, humidifier/dehumidifier, air conditioner, heat pump).

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	

DOK Rating	Competencies	
2	5.3.1.	Perform routine cleaning and inspection of system and components.
2	5.3.2.	Inspect and replace filters, belts and fluids.
3	5.3.3.	Recover, recharge and reclaim refrigerant from refrigeration and air conditioning equipment according to Environmental Protection Agency (EPA) regulations.
3	5.3.4.	Troubleshoot and service refrigeration and air conditioning equipment.
3	5.3.5.	Troubleshoot and service heating systems.

Outcome 5.4. Energy Assessment

Implement principles and guidelines needed to carry out effective energy assessments in accordance with the Building Energy Efficiency Ordinance.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	

DOK Rating	Competencies	
1	5.4.1.	Identify the requirements of an energy assessment.
2	5.4.2.	Collect data (e.g., measure square footage, window size, sun load, number of occupants, insulation R-value) and perform load calculation to select equipment.
3	5.4.3.	Calculate the energy and cost savings due to improvement in electrical, mechanical and plumbing systems performance and power quality.

Outcome 5.5. Boiler Systems

Describe and monitor the operation of hydronic and steam boiler systems.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	

DOK Rating	Competencies	
2	5.5.1.	Compare the uses and components of hydronic and steam boiler systems.
2	5.5.2.	Observe and test system operations and safety controls.
3	5.5.3.	Perform service maintenance and repair procedures for hydronic and steam boiler systems.

Outcome 5.6. Sheet Metal

Fabricate and install ductwork systems.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
	X	

DOK Rating	Competencies	
1	5.6.1.	Identify the components of a duct system.
1	5.6.2.	Select materials to fabricate ductwork based on job specifications.
2	5.6.3.	Lay out, cut and shear ductwork and fittings.
2	5.6.4.	Bend, fold, form and assemble a ductwork system.
2	5.6.5.	Seal and insulate ductwork.
2	5.6.6.	Fasten and hang ductwork.
2	5.6.7.	Install drive cleats and S-lock in ductwork.
2	5.6.8.	Describe the impact of modifying structural members of ductwork without weakening the structure.
2	5.6.9.	Take field measurements and translate them to sketch for shop fabrication.

Outcome 5.7. Drainage

Rough in drainage systems following plumbing codes and standards in interior and exterior applications.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	

DOK Rating	Competencies	
2	5.7.1.	Locate drainage system entry points, walls, and chases.
1	5.7.2.	Identify components of a drainage system and describe their functions.
1	5.7.3.	Describe how waste moves from a fixture through the drain system to the environment.
1	5.7.4.	Describe factors that are considered when planning and installing a wastewater drainage system.
2	5.7.5.	Estimate and compute length, angle of measurement, area, surface area and volume to calculate pipe legs and pipe sizes.
1	5.7.6.	Calculate the slope required for draining components.
2	5.7.7.	Select drainage components based on their application for a given purpose.
2	5.7.8.	Describe the impact of modifying structural members for drainage lines without weakening the structure.
1	5.7.9.	Identify and explain the installation of pipe sleeves or thimbles through walls, ceilings or floors.
2	5.7.10.	Join pipe, pipefittings and valves of similar and dissimilar materials using solvents and mechanical means of joining.
1	5.7.11.	Identify and explain the installation of plumbing fixtures and appliances to a drain system.
2	5.7.12	Test the drainage system for leaks.
2	5.7.13.	Locate cleanout access points and clear obstructions from lavatories, water closets and sinks.
1	5.7.14.	Describe the design, basic operation and care of a septic system.
2	5.7.15.	Determine the location and type of sewer drainpipes and storm drains.
1	5.7.16.	Identify and explain the installation of sewer drainpipes, septic tanks and storm drains.

Outcome 5.8. Water Systems

Rough in water systems following plumbing codes and standards, in interior and exterior applications.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	

DOK Rating	Competencies	
2	5.8.1.	Compare and contrast sources of contamination in water supplies and methods of disinfecting water.
1	5.8.2.	Explain the types and applications of pumps and pump controls used in water supplies.
2	5.8.3.	Prevent freezing and mechanical damage to pipes.
1	5.8.4.	Describe how water moves from the source through the water distribution system to the fixture.
2	5.8.5.	Describe ways in which a water supply system can become contaminated and prepare a water sample for analysis by a testing laboratory.
2	5.8.6.	Describe factors to consider when planning and installing a water distribution system.
2	5.8.7.	Estimate and compute length, angle of measurement, area, surface area and volume to calculate pipe legs and pipe sizes.
2	5.8.8.	Locate water supply system entry points, walls and chases.
1	5.8.9.	Describe the function of the pipe, pipefittings, valves and fixtures that comprise a water supply system.
2	5.8.10.	Select water supply components based on their application for a given purpose.
2	5.8.11.	Explain the impact of modifying structural members for water supply lines without weakening the structure.
2	5.8.12.	Join water supply pipe, pipefittings and valves of similar and dissimilar materials using solder, brazing, solvents and mechanical means of joining.
2	5.8.13.	Connect water supply to plumbing fixtures and appliances.
2	5.8.14.	Test a water supply system for leaks and pressure using soap, inert gas, electronic sensors and fluorescent dye.
2	5.8.15.	Perform maintenance on water supply components of plumbing fixtures and appliances.

Outcome 5.9. Fuel Piping Systems

Construct fuel piping systems following codes and standards for interior and exterior applications.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	

DOK Rating	Competencies	
2	5.9.1.	Identify the types of fuel systems and describe the advantages and disadvantages of each.
1	5.9.2.	Describe the physical properties and potential hazards associated with different fuel types.
1	5.9.3.	Describe the pipe, fittings, and valves used in fuel piping systems and describe their functions.
2	5.9.4.	Join pipe, fittings, and valves used in a piping system that transfers fuel.
2	5.9.5.	Connect appliances and equipment to fuel piping systems.
2	5.9.6.	Describe fuel piping testing methods and perform leak tests.

Strand 6. Construction Management and Jobsite Maintenance

Learners apply principles of business, facility and site operations and project management to build and operate residential, commercial and industrial facilities. Knowledge and skill may be applied in managing and supervising site operations; developing work sequences for tasks and units of work; coordinating material and equipment delivery; planning building stages and the build environment; and providing facility management, and maintenance services.

Outcome 6.1. Construction Math

Apply math and measurement principles to complete construction projects.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating	Competencies	
1	6.1.1.	Calculate surface area and volume for three-dimensional objects, accurate to a specified level of precision.
1	6.1.2.	Apply measurement scales to layout length, width, and angle measurements.
1	6.1.3.	Apply algebraic procedures and geometric concepts to reading construction documents.
1	6.1.4.	Use proportional reasoning and apply indirect measurement techniques (e.g., right triangle trigonometry, properties of similar triangles).
1	6.1.5.	Select and use measurement tools (i.e., grade rod, ruler, tape measure, measuring cups, builder's level).
1	6.1.6.	Perform calculations and conversions with fractions, decimals, and percents.
1	6.1.7.	Perform unit conversions.

Outcome 6.2. Construction Drawings

Read and interpret plans and diagrams within a construction drawing set (i.e., topographical, grading and drainage, architectural, structural, plumbing, mechanical, electrical) to organize a project work sequence.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating	Competencies	
2	6.2.1.	Collect and analyze project information to determine resources and tasks required to complete a project.
2	6.2.2.	Read and interpret a site plan.
2	6.2.3.	Use architect's and engineer's scales to read and interpret construction drawings for material calculations and installation at the jobsite.

2	6.2.4.	Read, interpret, and organize construction drawings, models, specifications and other contractual documents.
2	6.2.5.	Describe various building sections, wall sections and other architectural details of residential, commercial, utility, and highway construction.
2	6.2.6.	Identify and interpret aspects of sustainable design and construction techniques in construction drawings and specifications.
2	6.2.7.	Identify and interpret aspects of the Americans with Disabilities Act (ADA) in construction drawings and specifications.
2	6.2.8.	Read and interpret various 3-D and other Computer Aided Design (CAD) generated views in construction drawings.
2	6.2.9.	Read and interpret various Building Information Modeling (BIM) generated views in construction drawings.

Outcome 6.3. Construction Estimating

Develop an estimate of material, time, personnel, and equipment needs, availability, and cost for various construction types.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	X

DOK Rating	Competencies	
3	6.3.1.	Complete a site inventory and analysis, including the physical conditions, code, and utilities requirements and the environmental impact.
2	6.3.2.	Identify necessary material, time, personnel, and equipment to be used in construction projects.
3	6.3.3.	Calculate cost of identified materials, time, personnel and equipment to be used in construction projects.
3	6.3.4.	Develop a program list including intended use, budget, economics, customer wants and needs, and maintenance.

Outcome 6.4. Construction Scheduling

Organize materials and equipment delivery to maximize productivity.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	

DOK Rating	Competencies	
2	6.4.1.	Describe the schedule of labor, delivery of materials/equipment and the effect on employer cash flow and construction economics.
2	6.4.2.	Prescribe material and equipment storage needs and location on different types of job sites (e.g., access, delivery, protection from the elements, security).
2	6.4.3.	Create a schedule of construction and installation.
3	6.4.4.	Prepare and process unused material inventory for return credit.

Outcome 6.5. Field Organization

Summarize the sequence of building stages, systems quality control, and inspection processes within a build environment.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X		X

DOK Rating	Competencies	
2	6.5.1.	Identify the Critical Path Method (CPM) to select and sequence the appropriate building stages and explain their relationships in completing a construction project.
2	6.5.2.	Identify the various material testing techniques (e.g., hardness, tensile strength, bearing capacity, wear resistance, and soil tests).
2	6.5.3.	Describe the steps to commissioning and/or recommissioning process for a facility and its mechanical equipment.
2	6.5.4.	Describe the process to a walkthrough and creation of a punchlist to ensure conformity with plans, specifications and authorized change orders.
2	6.5.5.	Identify a final inspection order to obtain certificate of occupancy.
2	6.5.6.	Describe the sustainable building evaluation and certification process.
2	6.5.7.	Identify the roles and goals of construction professionals within a given delivery system (e.g., owners, architects, engineers, suppliers, general and trade contractors, consultants, regulators).

Outcome 6.6. Building Maintenance

Provide maintenance, repair and renovations to maintain the long-term conversation and protection of facility buildings and grounds.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X		

DOK Rating	Competencies	
2	6.6.1.	Identify types of surface material (porous/nonporous) to determine processes and chemicals needed to clean and maintain floors using manufacturers' recommendations.
1	6.6.2.	Identify type of carpet (e.g., fibers, styles, construction methods) and associated processes and procedures used for cleaning.
2	6.6.3.	Perform interim maintenance used in extending the life of the floor surfaces and coverings.
2	6.6.4.	Identify hard, resilient, and wood floor coverings and use procedures (e.g., scrubbing, stripping, buffing, high-speed burnishing, screening, sealing), chemicals and equipment needed to maintain and extend the life of the flooring.
1	6.6.5.	Describe sustainable, healthy, and high-performance cleaning.
3	6.6.6.	Develop and implement a custodial care plan (i.e., custodial duties and frequency; routine, renovation, supervisory, management activities) that provides a safe and healthy environment for a facility and analyzes efficiency based on hours and square footage.
2	6.6.7.	Select procedures and processes needed to clean, disinfect and maintain wall surfaces (e.g., painted, tiled, papered, plastered).
2	6.6.8.	Clean and disinfect lavatories and kitchen in accordance with health and safety guidelines.
1	6.6.9.	Replenish consumable supplies and maintain levels of inventory.
2	6.6.10.	Collect and dispose solid and hazardous waste in accordance with local codes and green initiatives.
3	6.6.11.	Develop a green cleaning program that identifies cleaning procedures, services, equipment, and supplies that provide improvements in ergonomics and reduce the effect on human health without harming the environment.
2	6.6.12.	Schedule preventative maintenance, repair, and renovation to maintain a safe and healthy environment using computer-aided facilities management programs as appropriate.
3	6.6.13.	Develop and implement a waste management and recycling plan that reduces costs based on local codes and regulations.
3	6.6.14.	Develop and implement an integrated pest management plan that reduces environmental impact and reduces cost.
2	6.6.15.	Identify the need for a water and energy conservation and management plan.
1	6.6.16.	Compare and contrast green and traditional practices in the selection of materials, chemicals and equipment.

Strand 7. Planning and Design

Learners apply principles of architectural and civil engineering, drawing and construction with current technology to develop, present and use construction proposals, plans and schematics. Knowledge and skill may be applied throughout the project from preconstruction design through all stages of building in residential, commercial and industrial applications.

Outcome 7.1. Proposals

Develop and present a design, proposal, or concept.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X		

DOK Rating	Competencies	
1	7.1.1.	Differentiate between residential, commercial, industrial, infrastructure, and institutional construction segments.
2	7.1.2.	Collect and analyze data to identify required deliverables (e.g., reports, studies, building designs, drawings) based on client specifications.
3	7.1.3.	Conceptualize design through hand drawing.
3	7.1.4.	Create a visualization of a proposed project using data from relevant materials according to client specifications and in compliance with building codes.
3	7.1.5.	Incorporate building structural systems, environmental systems, safety systems, building envelope systems and building service systems into the design.
3	7.1.6.	Incorporate sustainable design and construction techniques.
3	7.1.7.	Incorporate the Americans with Disabilities Act (ADA) Standards for Accessible Design.
4	7.1.8.	Develop and present the comprehensive proposal.

Outcome 7.2. Community Planning

Compare and contrast construction planning in urban and rural areas.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X	X	

DOK Rating	Competencies	
1	7.2.1.	Identify components necessary to managing municipal functions.
1	7.2.2.	Describe the roles of city governments in community planning.
2	7.2.3.	Examine problems of mass movement and spatial reorganization generated by expanding populations.
2	7.2.4.	Identify implementation tools for orderly, efficient and equitable development and arrangement of land (i.e., zoning, development regulations, capital improvement programs).
2	7.2.5.	Discuss appropriate health and social programs to improve the standard of living for those lacking in resources and/or opportunities.
2	7.2.6.	Examine the preservation of historic buildings, neighborhoods and sites to implement a cultural appreciation of architecture and geographic heritage through the protection of the physical representations of that heritage.
2	7.2.7.	Compare the community goals and objectives to the coordination of the transportation network.
2	7.2.8.	Analyze housing problems and opportunities.
2	7.2.9.	Identify economic development resources (e.g., policy development) for attracting and retaining industries.
2	7.2.10.	Integrate environmental values (e.g., preservation of wetlands, air quality strategies, protection of natural areas) into land use and other community plans.
2	7.2.11.	Merge the harmonious design (e.g., culture, related buildings and areas, aesthetics) of urban areas with urban policy.
2	7.2.12.	Examine the strategies for regional and national development (i.e., modernization and urbanization, transportation, rural development patterns, sustainable development, related strategies of economic development).
2	7.2.13.	Examine the economic factors that determine whether and where development, restoration and other investments occur.

Outcome 7.3. Drafting

Design residential, industrial, civil and commercial plans in accordance with the current American Institute of Architects (AIA) Architectural Graphic Standards.

An "X" indicates that the pathway applies to the outcome.

Design	Mechanical, Electrical, Plumbing	Structural
X		

DOK Rating	Competencies	
4	7.3.1.	Construct site plans in accordance with the current American Institute of Architects (AIA) Architectural Graphic Standards, (e.g., zoning, property lines, utilities, building line, setback).
4	7.3.2.	Construct scaled orthographic drawings to illustrate floor plans with appropriate adjacencies, traffic patterns, orientation of spaces and section views (e.g., stairway section, wall, cabinet elevations, building corners, elevation) in accordance with the current American Institute of Architects (AIA) Architectural Graphic Standards.
4	7.3.3.	Construct foundation and roof plans in accordance with the current American Institute of Architects (AIA) Architectural Graphic Standards.
4	7.3.4	Construct mechanical, electrical, infrastructure, and plumbing plans and schematics in accordance with the current American Institute of Architects (AIA) Architectural Graphic Standards.
3	7.3.5.	Incorporate public spaces and cultural aesthetics in commercial structures.
1	7.3.6.	Identify the role of Computer Aided Design (CAD) and Building Information Modeling (BIM) in Construction drafting.
1	7.3.7.	Identify the parties involved and the roles each play in the Building Information Modeling (BIM) process from conceptual design through construction completion and into facility management.
2	7.3.8.	Describe the Building Information Modeling (BIM) process from conceptual design through construction completion and into facility management.