Electrical Technology

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Office of the State Superintendent of Education
Postsecondary and Career Education Division
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The purpose of this document is to communicate the required Career and Technical Education (CTE) academic standards for the Electrical Technology Program of Study. The academic standards in this document are theoretical and performance-based. The standards contain content from Colorado, Maryland, Tennessee, and Texas and were validated by D.C. business and industry partners. All content is used with permission.

In addition to academic standards, OSSE has incorporated into this document Labor Market Information (LMI) definitions and explanations for the Program of Study; program aligned Industry Recognized Credentials; Work-Based Learning resources and requirements by course level; and a recommended equipment and supply list.

This document is intended for use by educational administrators and practitioners. A similar document is available for each state-approved CTE Program of Study.

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Course Descriptions: Electrical Technology		
Course Level	**Course Information**	**Description**
Level I	**Principles of Construction** **OSSEID:** 17002G1.0014 **Grades:** 9-12 **Prerequisite:** None **Credit:** 1	Principles of Construction is intended to provide an introduction and lay a solid foundation for those students entering the construction or craft skilled areas. The course provides a strong knowledge of construction safety, construction mathematics, and common hand and power tools. For safety and liability considerations, limiting course enrollment to 15 students is recommended. This course also provides communication and occupation skills to assist the student in obtaining and maintaining employment.
Level II	**Electrical Technology I** **OSSEID:** 17102G1.0024 **Grades:** 10-12 **Prerequisite:** Principles of Construction **Credit:** 1	In Electrical Technology I, students will gain knowledge and skills needed to enter the workforce as an electrician or building maintenance supervisor, prepare for a postsecondary degree in a specified field of construction or construction management, or pursue an approved apprenticeship program. Students will acquire knowledge and skills in safety, electrical theory, tools, codes, installation of electrical equipment, and the reading of electrical drawings, schematics, and specifications.
Level III	**Electrical Technology II** **OSSEID:** 17102G1.0034 **Grades:** 11-12 **Prerequisite:** Electrical Technology I **Credit:** 1	In Electrical Technology II, students will gain advanced knowledge and skills needed to enter the workforce as an electrician, a building maintenance technician, or a supervisor; prepare for a postsecondary degree in a specified field of construction or construction management or pursue an approved apprenticeship program. Students will acquire knowledge and skills in safety, electrical theory, tools, codes, installation of electrical equipment, alternating current and direct current motors, conductor installation, installation of electrical services, and electric lighting installation.
Level IV	**Practicum in Architectural Design** **OSSEID:** 17951G1.0044 **Grades:** 12 **Prerequisite:** Electrical Technology II **Credit:** 1	Practicum in Construction Technology, students will be challenged with the application of knowledge and skills gained in previous construction-related coursework. In many cases, students will be allowed to work at a job (paid or unpaid) outside of school or be involved in local projects the school has approved for this class.

Industry Certifications

OSHA 10
Electrical Apprenticeship Certificate Level 1
NCCER (National Center for Construction Education and Research) Electrical, Level 1
NCCER (National Center for Construction Education and Research) Electrical, Level 2

Work-Based Learning Examples and Resources

Level I Course	Level II Course	Level III Course	Level IV Course
Career Exploration Industry Visits Guest Speakers Participate in a CTSO	**Career Awareness** *All of Level I, plus:* Postsecondary Visits Program-Specific Site Tours Mock Interviews	**Career Preparation** *All of Level I and II, plus:* Job Shadow Paid/Unpaid Internships	**Career Preparation** Paid/Unpaid Internships Apprenticeships

Several resources are available to help instructors meet the Level I and Level II WBL requirements, including:

Career Coach DC (http://careercoachdc.emsicc.com). Online site designed to help students find and connect to a career pathway by providing the most current local data on wages, employment, job postings, and associated education and training. The resource includes a Career Assessment for students.

Nepris (https://dc.nepris.com/). Connects educators and learners with a network of industry professionals virtually, bringing real-world relevance and career exposure to all students. Nepris also provides a skills-based volunteering platform for business and industry professionals to extend their educational outreach.

Virtual Job Shadow (https://virtualjobshadow.com). Provides interactive tools which empower students to discover, plan, and pursue their dreams. Rich video library presents a "day in the life of" view for thousands of occupations

Labor Market Information Definitions and Data

Career and Technical Education programs of study in the District of Columbia must meet at least one of the High Wage, High Skill, and In-Demand definitions below to be considered appropriate for our students and the regional labor market. These definitions were created in collaboration with Career and Technical Education leaders from District of Columbia LEAs, the University of the District of Columbia Community College, and national guidance from Research Triangle International (RTI) and Education Northwest. Additionally, previous work was consulted by researchers at MIT's Labor Wage Index Project and the DC CTE Task Force's 2012 Strategic Plan for the District of Columbia.

Indicator	Definition	Data for the Electrical Technology Program of Study (source: EMSI, August 2022)
High Wage	Those occupations that have a 25th percentile wage equal to or greater than the most recent MIT Living Wage Index for one adult in the District of Columbia and/or leads to a position that pays at least the median hourly or annual wage for the Washington, DC, metropolitan statistical area. *Note: A 25th percentile hourly wage of $23.13 or greater is required to meet this definition.*	**Standard Occupational Code (SOC):** 47-2111.00 Electricians **Hourly Wages** **25th Percentile:** $24.45 **50th Percentile:** $31.49 **75th Percentile:** $40.88

High Skill	Those occupations located within the Washington, DC, metropolitan statistical area with the following education or training requirements: completion of an apprenticeship program; completion of an industry-recognized certification or credential; associate's degree, or higher.	**Typical Entry-Level Education:** High School Diploma or Equivalent
In-Demand	Those occupations in the Washington, DC, metropolitan statistical area having more than the median number of total ***(growth plus replacement)*** annual openings over a five-year period. *Note: An occupation is required to have an annual growth plus replacement rate of 105 openings, or greater, between 2021-2026 to meet this definition.*	**Annual Openings:** 3,076

Model Six-Year Plan: Electrical Technology

College: University of the District of Columbia Community College
Program/CIP:
Plan:

Entity: Office of the State Superintendent of Education
Career Cluster: Architecture and Construction
Program of Study: Electrical Technology

High School					College			
Subject	**9th Grade**	**10th Grade**	**11th Grade**	**12th Grade**	**Semester I**	**Semester II**	**Semester III**	**Semester IV**
English (4)	English I	English II	English III	English IV				
Math (4)	Algebra I	Geometry	Algebra II	Math				
Science (4)	Biology	Lab Science	Lab Science	Science				
Social Studies (4)	World History and Geography I: Middle Ages	World History and Geography II: Modern World	U.S. History	U.S. Government (.5) and D.C. History (.5)				
Health (.5) and Physical Ed (1)	Health (.5) Physical Ed (.5)	Physical Ed (.5)						
World Languages (2)			World Language I	World Language II				
Art (.5)		Art (.5)						
Music (.5)		Music (.5)						
Elective / Major Courses	Principles of Construction	Electrical Technology I	Electrical Technology II	Practicum in Construction Technology				
Total possible college credits completed in high school: XX					***Credit hours required to complete the AAS program: XX***			

Course Standards

Principles of Construction

1. **General requirements.** This course is recommended for students in Grades 9-12. Students shall be awarded one credit for successful completion of this course.

2. **Introduction.**
   A. Career and technical education instruction provides students with industry-aligned content, challenging academic standards, and relevant technical knowledge to further their education and succeed in current or emerging professions.

   B. The Architecture and Construction Career Cluster focuses on designing, planning, managing, building, and maintaining the built environment.

   C. Principles of Construction is intended to provide an introduction and lay a solid foundation for those students entering the construction or craft skilled areas. The course provides a strong knowledge of construction safety, construction mathematics, and common hand and power tools. For safety and liability considerations, limiting course enrollment to 15 students is recommended. This course also provides communication and occupation skills to assist the student in obtaining and maintaining employment.

   D. Students will participate in at least two Career Exploration Work-Based Learning experiences in this course, which might include guest speakers and workplace tours relevant to the program of study.

   E. Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

3. **Knowledge and skills.**
   A. **The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:**
      1. explain the role of an employee in the construction industry;
      2. demonstrate critical-thinking skills;
      3. demonstrate the ability to solve problems using critical-thinking skills;
      4. demonstrate knowledge of basic computer systems;
      5. explain common uses for computers in the construction industry;
      6. define effective relationship skills;
      7. recognize workplace issues such as sexual harassment, stress, and substance abuse;
      8. explain the Occupational Safety and Health Administration (OSHA) General Duty Clause; and
      9. explain OSHA 1926 CFR Subpart C.

   B. **The student understands that safe working standards are imperative in the classroom and in the field. The student is expected to:**
      1. explain the idea of a safety culture;
      2. explain the importance of a safety culture in the construction crafts;
      3. explain the role of the OSHA in job-site safety;

4. explain fall protection, ladder safety, stair safety, and scaffold safety procedures;
5. demonstrate the use and care of appropriate personal protective equipment, including safety goggles and glasses, hard hats, gloves, safety harnesses, and safety shoes;
6. define safe work procedures around electrical hazards; and
7. explain the importance of Safety Data Sheets (SDS).

C. **The student understands the importance of recognizing potential hazards and preventing accidents in the classroom and in the field. The student is expected to:**
1. identify causes of accidents;
2. identify impacts of accident costs;
3. define hazard recognition;
4. identify struck-by hazards;
5. identify caught-in-between hazards;
6. identify other construction hazards on the jobsite, including hazardous material exposures, environmental elements, welding and cutting hazards, confined spaces, and fires; and
7. explain the importance of hazard communication (HazCom).

D. **The student understands basic construction mathematics. The student is expected to:**
1. add, subtract, multiply, and divide whole numbers with and without a calculator;
2. add, subtract, multiply, and divide fractions;
3. add, subtract, multiply, and divide decimals with and without a calculator;
4. convert decimals to percentages and percentages to decimals; and
5. convert fractions to decimals and decimals to fractions.

E. **The student demonstrates basic measuring practices. The student is expected to:**
1. use a standard ruler, a metric ruler, a measuring tape, and an architectural/engineering scale to measure;
2. explain what the metric system is and how it is important in the construction trade;
3. recognize and use metric units of length, weight, volume, and temperature; and
4. recognize some of the basic shapes used in the construction industry and apply basic geometric principles to measure them.

F. **The student acquires knowledge about care and identification of hand tools. The student is expected to:**
1. recognize and identify the basic hand tools and their purposes for the construction trades;
2. inspect basic hand tools visually to determine if they are safe for use; and
3. use the basic construction hand tools safely and properly.

G. **The student acquires knowledge about care and identification of powered hand tools. The student is expected to:**
1. identify powered hand tools commonly used in the construction trades;
2. practice safe and proper application of powered hand tools commonly used in the construction trades; and
3. explain how to properly maintain and clean powered hand tools commonly used in construction trades.

H. **The student develops the basics of construction drawing. The student is expected to:**
1. interpret and use drawing dimensions;
2. recognize and identify basic construction terms;

3. recognize and identify basic drawing components;
4. recognize and identify commonly used drawing symbols;
5. relate information on construction drawings to actual locations on the print; and
6. recognize different classifications of construction drawings.

I. **The student reads technical drawings and documents to plan a project. The student is expected to:**
1. interpret blueprints and drawings to assist with project planning;
2. recognize elements and symbols of blueprints and drawings;
3. relate information on blueprints to actual locations on the print;
4. recognize different classifications of drawings; and
5. interpret and use drawing dimensions.

J. **The student interprets and presents information used in workplace situations. The student is expected to:**
1. interpret information and instructions presented in written form;
2. interpret information and instructions presented in verbal form;
3. communicate effectively using verbal and writing skills; and
4. communicate effectively on the job using electronic communication devices.

K. **The student identifies ergonomic tools and procedures as well as safe material handling standards. The student is expected to:**
1. define a load;
2. establish a pre-task plan prior to moving a load;
3. apply proper material-handling techniques;
4. choose appropriate material-handling equipment for the task; and
5. recognize hazards and follow safety procedures required for material handling.

L. **The student develops technology skills. The student is expected to:**
1. Use technology as a tool to research, organize, evaluate, and communicate information;
2. Use digital technologies (computers, PDAs, media players, GPSs, etc.); communication/networking tools, and social networks appropriately to access, manage, integrate, evaluate, and create information to successfully function in a knowledge economy;
3. Demonstrate using current and new technologies specific to the program of study, course, and/or industry; and
4. Apply a fundamental understanding of the ethical/legal issues surrounding the access and use of information technologies.

Electrical Technology I

1. **General requirements.** This course is recommended for students in Grades 10-12. Prerequisite: Principles of Construction. Students shall be awarded one credit for successful completion of this course.

2. **Introduction.**
   A. Career and technical education instruction provides students with industry-aligned content, challenging academic standards, and relevant technical knowledge to further their education and succeed in current or emerging professions.

   B. The Architecture and Construction Career Cluster focuses on designing, planning, managing, building, and maintaining the built environment.

   C. In Electrical Technology I, students will gain knowledge and skills needed to enter the workforce as an electrician or building maintenance supervisor, prepare for a postsecondary degree in a specified field of construction or construction management, or pursue an approved apprenticeship program. Students will acquire knowledge and skills in safety, electrical theory, tools, codes, installation of electrical equipment, and the reading of electrical drawings, schematics, and specifications.

   D. Students will participate in at least two Career Awareness Work-Based Learning experiences in this course, which might include informational interviews or job shadowing relevant to the program of study.

   E. Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

3. **Knowledge and skills.**
   A. **The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:**
      1. identify job opportunities with their accompanying job duties such as electrician, building maintenance technician, manager, and electrical engineer; and
      2. research career pathways, including education, job skills, and experience required to achieve that pathway.

   B. **The student identifies the issues associated with electrical hazards found on a jobsite. The student is expected to:**
      1. demonstrate safe working procedures in a construction environment;
      2. explain the purpose of the Occupational Safety and Health Administration (OSHA) and how it promotes safety on the job;
      3. identify electrical hazards and how to avoid or minimize them in the workplace; and
      4. explain safety issues concerning lockout and tagout procedures, personal protection using assured grounding and isolation programs, confined space entry, respiratory protection, and fall protection.

   C. **The student learns conduit bending and installation. The student is expected to:**
      1. identify the methods of hand bending conduit;
      2. identify the various methods used to install conduit;
      3. use mathematical formulas to determine conduit bends;

4. make 90-degree bends, back-to-back bends, offsets, kicks, and saddle bends using a hand bender; and
5. cut, ream, and thread conduit.

D. **The student gains knowledge of the hardware and systems used by an electrician to mount and support boxes, receptacles, and other electrical components. The student is expected to:**
1. identify and explain the use of threaded fasteners;
2. identify and explain the use of non-threaded fasteners;
3. identify and explain the use of anchors;
4. demonstrate the correct applications for fasteners and anchors; and
5. install fasteners and anchors.

E. **The student learns the electrical concepts used in Ohm's law applied to direct current and series circuits and understands series-parallel circuits, resistive circuits, Kirchhoff's voltage and current laws, and circuit analysis. The student is expected to:**
1. recognize what atoms are and what atoms are composed of;
2. define voltage and identify the ways in which it can be produced;
3. explain the difference between conductors and insulators;
4. define the units of measurement used to measure the properties of electricity;
5. explain how voltage, current, and resistance are related to each other;
6. calculate an unknown value using the formula for Ohm's law;
7. explain the different types of meters used to measure voltage, current, and resistance;
8. calculate the amount of power used by a circuit using the power formula;
9. explain the basic characteristics of a series, parallel, and combined series-parallel circuit;
10. calculate, using Kirchhoff's current law, the total current in parallel and series-parallel circuits; and
11. find the total amount of resistance in a series, parallel, or combined series-parallel circuit.

F. **The student gains knowledge in selecting, using, and safely maintaining common electrical test equipment. The student is expected to:**
1. explain how to operate test equipment such as ammeter, ohmmeter, volt-ohm-multimeter, continuity tester, and voltage tester;
2. explain how to read specific test equipment and convert from one scale to another when using specified test equipment;
3. explain the importance of proper meter polarity; and
4. explain the difference between digital and analog meters.

G. **The student uses the National Electrical Code. The student is expected to:**
1. explain the purpose and history of the National Electrical Code;
2. describe the layout of and explain how to navigate the National Electrical Code;
3. describe the purpose of the National Electrical Manufacturers Association and National Fire Protection Association; and
4. explain the role of testing laboratories.

H. **The student learns the types and applications of raceways, wireways, and ducts. The student is expected to:**
1. describe various types of cable trays and raceways;
2. identify and select various types and sizes of raceways;

3. identify and select various types and sizes of cable raceways;
4. identify and select various types of raceway fittings;
5. identify various methods used to install raceways;
6. demonstrate knowledge of National Electrical Code raceway requirements;
7. describe procedures for installing raceways and boxes on masonry surfaces, metal stud systems, wood-framed systems, and drywall surfaces; and
8. recognize safety precautions that must be followed when working with boxes and raceways.

I. **The student learns the types and applications of conductors and wiring techniques. The student is expected to:**
1. demonstrate the various wire sizes using a wire in accordance with American Wire Gauge standards;
2. identify insulation and jacket types according to conditions and applications;
3. describe voltage ratings of conductors and cables;
4. read and identify markings on conductors and cables;
5. use the tables in the National Electrical Code to determine the ampacity of a conductor;
6. state the purpose of stranded wire;
7. state the purpose of compressed conductors;
8. describe the different materials from which conductors are made;
9. describe the different types of conductor insulation;
10. describe the color coding of insulation;
11. describe instrumentation control wiring;
12. describe the equipment required for pulling wire through conduit;
13. describe the procedure for pulling wire through conduit;
14. install conductors in conduit; and
15. pull conductors in a conduit system.

J. **The student learns electrical symbols and their use in design drawings. Additionally, students learn to interpret schematics, one-line diagrams, and wiring diagrams. The student is expected to:**
1. explain the basic layout of a design drawing;
2. describe the information included in the title block of a drawing;
3. identify common symbols and the various types of lines used on drawings;
4. understand the use of architect's and engineer's scales;
5. interpret electrical drawings such as site plans, floor plans, and detail drawings;
6. read equipment schedules found on electrical drawings; and
7. describe the type of information included in electrical specifications.

K. **The student learns the electrical devices and wiring techniques used in commercial and industrial construction and maintenance. The student is expected to:**
1. identify and state the functions and ratings of special switches such as single-pole, double-pole, three-way, four-way, dimmer, and safety switches;
2. explain National Electrical Manufacturers Association classifications as they relate to switches and enclosures;
3. explain the National Electrical Building Code requirements concerning wiring devices;
4. identify and state the functions and ratings of wiring devices such as straight blade, twist lock, and pin and sleeve receptacles;

5. identify and define receptacle terminals and disconnects;
6. identify and define ground fault circuit interrupters;
7. explain the box mounting requirements in the National Building Code;
8. use appropriate tools and connectors to strip and splice wires together;
9. identify and state the functions of limit switches and relays; and
10. identify and state the function of switchgear.

L. **The student learns the electrical devices and wiring techniques used in residential construction maintenance. The student is expected to:**
1. describe how to determine electric service requirements for dwellings;
2. explain the grounding requirements of a residential electric service;
3. calculate and select service-entrance equipment;
4. select the proper wiring methods for various types of residences;
5. explain the role of the National Electrical Code in residential wiring;
6. compute branch circuit loads and explain their installation requirements;
7. explain the types and purposes of equipment grounding conductors;
8. explain the purpose of ground-fault circuit interrupters and tell where they must be installed;
9. determine the size of outlet boxes and select the proper type for different wiring methods;
10. describe rules for installing electric space heating and heating, ventilating, and air conditioning equipment;
11. describe the installation rules for electrical systems around swimming pools, spas, and hot tubs;
12. describe the installation and control of lighting fixtures; and
13. explain how wiring devices are selected and installed.

M. **The student develops technology skills. The student is expected to:**
1. Use technology as a tool to research, organize, evaluate, and communicate information;
2. Use digital technologies (computers, PDAs, media players, GPSs, etc.); communication/networking tools, and social networks appropriately to access, manage, integrate, evaluate, and create information to successfully function in a knowledge economy;
3. Demonstrate using current and new technologies specific to the program of study, course, and/or industry; and
4. Apply a fundamental understanding of the ethical/legal issues surrounding the access and use of information technologies.

Electrical Technology II

1. **General requirements.** This course is recommended for students in Grades 11 and 12. Prerequisite: Electrical Technology I. Students shall be awarded one credit for successful completion of this course.

2. **Introduction.**
   A. Career and technical education instruction provides students with industry-aligned content, challenging academic standards, and relevant technical knowledge to further their education and succeed in current or emerging professions.

   B. The Architecture and Construction Career Cluster focuses on designing, planning, managing, building, and maintaining the built environment.

   C. In Electrical Technology II, students will gain advanced knowledge and skills needed to enter the workforce as an electrician, a building maintenance technician, or a supervisor; prepare for a postsecondary degree in a specified field of construction or construction management, or pursue an approved apprenticeship program. Students will acquire knowledge and skills in safety, electrical theory, tools, codes, installation of electrical equipment, alternating current and direct current motors, conductor installation, installation of electrical services, and electric lighting installation.

   D. Students will participate in a Career Preparation Work-Based Learning experience in this course, which might include paid or unpaid internship experiences relevant to the program of study.

   E. Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

3. **Knowledge and skills.**
   A. **The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:**
      1. identify job opportunities with their accompanying job duties such as electrician, building maintenance technician, manager, and electrical engineer; and
      2. research careers along with the education, job skills, and experience required to achieve a career goal.

   B. **The student knows the issues associated with electrical hazards found on a jobsite. The student is expected to:**
      1. demonstrate safe working procedures in a construction environment;
      2. explain the purpose of the Occupational Safety and Health Administration (OSHA) and how it promotes safety on the job;
      3. identify electrical hazards and how to avoid or minimize them in the workplace; and
      4. explain safety issues concerning lockout and tagout procedures, personal protection using assured grounding and isolation programs, confined space entry, respiratory protection, and fall protection.

C. **The student gains knowledge of alternating current and direct current motors, with specific attention being given to main parts, circuits, and connections. The student is expected to:**

1. define terms such as ampacity, branch circuit, circuit breaker, controller, duty, full-load amps, ground fault circuit interrupter, interrupting rating, motor circuit switch, thermal protector, National Electrical Manufacturers Association design letter, non-automatic, overcurrent, overload, rated full-load speed, rated horsepower, remote control circuit, service factor, and thermal cutout;
2. describe the various types of motor enclosures;
3. describe how the rated voltage of a motor differs from the system voltage;
4. describe the basic construction and components of a three-phase squirrel cage induction motor;
5. explain the relationships among speed, frequency, and the number of poles in a three-phase induction motor;
6. describe how torque is developed in an induction motor;
7. explain how and why torque varies with rotor reactance and slip;
8. define percent slip and speed regulation;
9. explain how the direction of a three-phase motor is reversed;
10. describe the component parts and operating characteristics of a three-phase wound-rotor induction motor;
11. define torque, starting current, and armature reaction as they apply to direct current motors;
12. explain how the direction of rotation of a direct current motor is changed;
13. describe the design and characteristics of direct current shunt, series, and compound motors;
14. describe dual-voltage motors and their applications;
15. describe the methods for determining various motor connections; and
16. describe general motor protection requirements as delineated by the National Electrical Code.

D. **The student learns the purpose for grounding and bonding electrical systems. The student is expected to:**

1. explain the purpose of grounding and the scope of the National Electrical Code;
2. distinguish between a short circuit and a ground fault;
3. define the National Electrical Code ground-related terms;
4. distinguish between system grounding and equipment grounding;
5. use the National Electrical Code to size the grounding electrode conductor for various alternating current systems;
6. explain the National Electrical Code requirements for the installation and physical protection of grounding electrode conductors;
7. explain the function of the grounding electrode system and determine which grounding electrodes must be used;
8. define electrodes and explain the resistance requirements for electrodes using the National Electrical Code;
9. use the National Electrical Code to size the equipment grounding conductor for raceways and equipment;
10. explain the function of the main bonding jumper and system bonding jumpers in the grounding system and size the bonding jumpers for various applications;
11. size the main bonding jumper for a service using multiple service disconnecting means;
12. explain the National Electrical Code requirements for bonding of enclosures and equipment;
13. explain effective grounding and its importance in clearing ground faults and short circuits;
14. explain the purposes of the grounded conductor neutral in operation of overcurrent devices;
15. explain the National Electrical Code requirements for grounding separately derived systems, including transformers and generators;
16. explain the National Electrical Code requirements for grounding at more than one building; and

17. explain the National Electrical Code grounding requirements for systems over 600 volts.

E. **The student properly bends all sizes of conduit up to six inches. The student is expected to:**
   1. describe the process of conduit bending using power tools;
   2. identify all parts of popular electric and hydraulic benders;
   3. avoid excessive waste when working with conduit systems;
   4. bend offsets, kicks, saddles, and segmented and parallel bends;
   5. explain the requirements for the National Electrical Code for bending conduit;
   6. compute the radius, degrees in bend, developed length, and gain for conduit up to six inches; and
   7. explain how to correct damaged conduit and modify existing bends.

F. **The student learns to select and size outlet boxes, pull boxes, and junction boxes. The student is expected to:**
   1. describe the different types of nonmetallic and metallic boxes;
   2. calculate the required box size for any number and size of conductors;
   3. explain the National Electrical Code regulations for volume required per conductor in outlet boxes;
   4. locate, install, and support boxes of all types;
   5. describe the National Electrical Code regulations governing pull and junction boxes;
   6. explain the radius rule when installing conductors in pull boxes;
   7. understand the National Electrical Code requirements for boxes supporting lighting fixtures;
   8. describe the purpose of conduit bodies and Type F.S. boxes;
   9. install the different types of fittings used in conjunction with boxes;
   10. describe the installation rules for boxes and fittings in hazardous areas;
   11. explain how boxes and fittings are selected and installed; and
   12. describe the various types of box supports.

G. **The student knows transportation, storage, and setup of cable reels, methods of rigging, and procedures to complete cable pulls in raceways and cable trays. The student is expected to:**
   1. describe the various methods of installing conductors in conduit;
   2. plan and set up for a cable pull;
   3. describe how cable reels are transported to the pulling site;
   4. set up reel stands and spindles for a wire-pulling installation;
   5. explain how mandrels, swabs, and brushes are used to prepare conduit for conductors;
   6. install a pull line for a cable-pulling operation;
   7. explain the operation of power fish tape systems;
   8. prepare the ends of conductors for pulling;
   9. describe the types of cable pullers;
   10. describe the process of high-force cable pulling;
   11. explain how to support conductors in vertical conduit runs;
   12. describe the installation of cables in cable trays;
   13. explain the importance of communication during a cable-pulling operation; and
   14. calculate the probable stress or tension in cable pulls.

H. **The student installs cable trays and modifies cable trays and cables. The student is expected to:**
   1. describe the components that make up a cable tray assembly;
   2. explain the methods used to hang and secure a cable tray;

3. describe how cable enters and exits cable trays;
4. select the proper cable tray fitting for the situation;
5. explain the National Electrical Manufacturers Association standards for cable tray installations;
6. explain the National Electrical Code requirements for cable tray installations;
7. select the required fittings to ensure equipment grounding continuity in cable tray systems;
8. interpret electrical working drawings showing cable tray fittings;
9. size a cable tray for the number and type of conductors contained in the system;
10. select rollers and sheaves for pulling cable in specific cable tray situations; and
11. designate the required locations of rollers and sheaves for a specific cable pull.

I. **The student knows the methods of terminating and splicing conductors of all types and sizes and the preparation and taping of conductors. The student is expected to:**
1. describe how to make a good conductor termination;
2. prepare cable ends for terminations and splices;
3. install lugs and connectors onto conductors;
4. train cable at termination points;
5. explain the role of the National Electrical Code in making cable terminations and splices;
6. explain why mechanical stress should be avoided at cable termination points;
7. describe the importance of using proper bolt torque when bolting lugs onto bus bars;
8. describe crimping techniques;
9. select the proper lug or connector for the job;
10. describe splicing techniques; and
11. explain how to use hand and power crimping tools.

J. **The student installs single- and three-phase services, including metering equipment. The student is expected to:**
1. describe various types of electric services for commercial and industrial installations;
2. read electrical drawings and diagrams describing service installation;
3. calculate and select service-entrance equipment;
4. explain the role of the National Electrical Code in-service installations;
5. install main disconnect switches, panel boards, and overcurrent protection devices;
6. identify the circuit loads, number of circuits required, and installation requirements for distribution panels;
7. explain the types and purposes of service grounding;
8. explain the purpose and required locations of ground fault circuit interrupters;
9. describe single-phase service connections; and
10. describe both wye-phase and delta-connected three-phase services.

K. **The student knows the practical application of fuses and circuit breakers. The student is expected to:**
1. explain the necessity of overcurrent protection devices in electrical circuits;
2. define the terms associated with fuses and circuit breakers;
3. describe the operation of a circuit breaker;
4. select the most suitable overcurrent device for the application;
5. describe the operation of single-element and time-delay fuses;
6. explain how ground fault circuit interrupters can save lives;
7. calculate short circuit currents; and

8. describe troubleshooting and maintenance techniques for overcurrent devices.

L. **The student knows the practical applications of contactors and relays. The student is expected to:**
1. describe the operating principles of contactors and relays;
2. select contractors and relays for use in specific electrical systems;
3. explain how mechanical contractors operate;
4. explain how solid-state contractors operate;
5. install contactors and relays according to National Electrical Code requirements;
6. select and install contactors and relays for lighting control;
7. describe how overload relays operate;
8. connect a simple control circuit; and
9. test control circuits.

M. **The student learns the basic principles of human vision and the characteristics of light. The student is expected to:**
1. explain how the human eye works;
2. describe the characteristics of light;
3. recognize the different kinds of lamps and explain the advantages and disadvantages of each type, including incandescent, halogen, fluorescent, and high-intensity discharge;
4. select and install lamps into lighting fixtures; and
5. recognize and install various types of lighting fixtures, including surface mounted, recessed, suspended, and track-mounted units.

N. **The student develops technology skills. The student is expected to:**
1. Use technology as a tool to research, organize, evaluate, and communicate information;
2. Use digital technologies (computers, PDAs, media players, GPSs, etc.); communication/networking tools, and social networks appropriately to access, manage, integrate, evaluate, and create information to successfully function in a knowledge economy;
3. Demonstrate using current and new technologies specific to the program of study, course, and/or industry; and
4. Apply a fundamental understanding of the ethical/legal issues surrounding the access and use of information technologies.

Practicum in Construction Technology

1. **General requirements.** This course is recommended for students in Grade 12. The practicum course is a paid or unpaid capstone experience for students participating in a coherent sequence of career and technical education courses in the Architecture and Construction Career Cluster. Prerequisite: Construction Technology II, Building Maintenance Technology II; Electrical Technology II; Heating, Ventilation, and Air Conditioning (HVAC) and Refrigeration Technology II; or Plumbing Technology I. Students shall be awarded one credit for successful completion of this course.

2. **Introduction.**
   A. Career and technical education instruction provides students with industry-aligned content, challenging academic standards, and relevant technical knowledge to further their education and succeed in current or emerging professions.

   B. The Architecture and Construction Career Cluster focuses on designing, planning, managing, building, and maintaining the built environment.

   C. In Practicum in Construction Technology, students will be challenged with the application of knowledge and skills gained in previous construction-related coursework. In many cases, students will be allowed to work at a job (paid or unpaid) outside of school or be involved in local projects the school has approved for this class.

   D. Students will participate in a Career Preparation Work-Based Learning experience in this course, which includes paid or unpaid internship, pre-apprenticeship, or apprenticeship experiences relevant to the program of study.

   E. Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

3. **Knowledge and skills.**
   A. **The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:**
      1. explain the role of an employee in the construction industry;
      2. demonstrate critical-thinking skills;
      3. demonstrate the ability to solve problems using critical-thinking skills;
      4. demonstrate knowledge of basic computer systems;
      5. explain common uses for computers in the construction industry;
      6. demonstrate effective relationship skills; and
      7. recognize workplace issues such as sexual harassment, stress, and substance abuse.

   B. **The student develops a management plan for a project or an activity. The student is expected to:**
      1. identify and describe the steps required to complete a project using project management processes, including initiating, planning, executing, monitoring and controlling, and closing a project;
      2. determine and acquire the resources needed to complete a project; and
      3. develop a project schedule.

C. **The student applies the appropriate codes, laws, standards, or regulations related to a research and development project. The student is expected to:**
   1. identify areas where codes, laws, standards, or regulations may be required;
   2. locate the appropriate codes, laws, standards, or regulations; and
   3. interpret and comply with the appropriate codes, laws, standards, or regulations.

D. **The student describes the expectations for each project using a flowchart. The student is expected to:**
   1. use an assessment strategy to determine the task's needs;
   2. describe why each task needs to be in the order it has been assigned;
   3. assess the time frame for each task; and
   4. plot a completed project flowchart expectation.

E. **The student solves problems, thinks critically, and makes decisions related to research, design, and development. The student is expected to:**
   1. develop or improve the project by following a problem-solving strategy;
   2. apply critical-thinking strategies to the analysis and evaluation of proposed technological solutions; and
   3. apply decision-making techniques to the selection of technological solutions.

F. **The student describes the costs associated with the project. The student is expected to:**
   1. develop a bill of materials list for the complete project;
   2. develop a budget, including a cost list, for the complete project; and
   3. determine the most effective way to minimize project costs.

G. **The student applies communication, mathematics, and science knowledge and skills to the construction activities. The student is expected to:**
   1. write technical reports;
   2. deliver technical presentations to the instructor;
   3. identify and describe the mathematical concepts used in projects; and
   4. identify and describe the science concepts used in projects.

H. **The student uses advanced tools, materials, processes, and procedures in the construction project. The student is expected to:**
   1. determine and use the appropriate technology needed to solve a problem or complete a task;
   2. evaluate the use of technology in a given situation; and
   3. describe the factors that influence the use of technology in a variety of situations.

I. **The student develops technology skills. The student is expected to:**
   1. Use technology as a tool to research, organize, evaluate, and communicate information;
   2. Use digital technologies (computers, PDAs, media players, GPSs, etc.); communication/networking tools, and social networks appropriately to access, manage, integrate, evaluate, and create information to successfully function in a knowledge economy;
   3. Demonstrate using current and new technologies specific to the program of study, course, and/or industry; and
   4. Apply a fundamental understanding of the ethical/legal issues surrounding the access and use of information technologies.