2009-2012 Mississippi Curriculum Framework

Postsecondary Electrical Technology
(Program CIP: 46.0302 – Electrician)

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**Related Academic Standards**

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Preface

Electrical Technology Research Synopsis

Articles, books, websites, and other materials listed at the end of each course were considered during the revision process. Specific journals, articles, and resources were especially useful in providing insight into trends and issues in the field. These references are suggested for use by instructors and students during the study of the topics outlined.

Industry advisory team members from colleges throughout the state were asked to give input related to changes to be made to the curriculum framework. Specific comments related to soft skills needed in this program included positive attitude, dependability, team player, flexibility, punctuality, good work ethic, initiative, and communication. Occupational-specific skills stated included computer use, math and estimating, blueprint reading, NEC and local codes, circuits, and motor controls. Safety practices emphasized included adhering to standard precautions and following OSHA guidelines.

Instructors from colleges throughout the state were also asked to give input on changes to be made to the curriculum framework. Specific comments related to this program included statements from Advisory Committee members to increase productivity and work ethics. Changes suggested for the curriculum included improving math skills, reading schematics, and safety practices. Introduction to Construction Technology (ELT 1173) was added as an elective.

Needs of the Future Workforce

The electrical occupation in Mississippi (16%) is projected to grow faster than average in the United States (10%) (EMSI, 2011). However, the median hourly earnings indicate that Mississippi electrical workers earn less than the national median wage earnings.

Electrical Technology Employment Projections and Earnings

<table>
<thead>
<tr>
<th>Region</th>
<th>2011 Jobs</th>
<th>2021 Jobs</th>
<th>Change</th>
<th>% Change</th>
<th>Openings</th>
<th>2011 Median Hourly Earnings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional Total</td>
<td>30,105</td>
<td>35,034</td>
<td>4,929</td>
<td>16%</td>
<td>11,215</td>
<td>$14.50</td>
</tr>
<tr>
<td>National Total</td>
<td>2,961,370</td>
<td>3,245,703</td>
<td>284,333</td>
<td>10%</td>
<td>907,473</td>
<td>$17.41</td>
</tr>
</tbody>
</table>

Curriculum

The following national standards were referenced in each course of the curriculum:

- **NCCER 2008 Electrical Level One and Two Modules**
- **CTB/McGraw-Hill LLC Tests of Adult Basic Education, forms 79 and 810 Academic Standards**
- **21st Century Skills**
- **Contren Learning Series for Electricity**

Industry and instructor comments, along with current research, were considered by the curriculum revision team during the revision process, and changes were made as needed and appropriate. Many of
the skills and topics noted in the research were already included in the curriculum framework. Specific changes made to the curriculum at the April 2008 curriculum revision meeting included the following:

**Add new courses:**
CTE 1163 Introduction to Sustainable and Renewable Energy
CTE 1153 Computational Methods for Career and Technical Education
CTE 1143 Fundamentals of Construction and Manufacturing

- Competencies and objectives were reviewed to ensure accuracy and appropriateness.
- **Competencies and objectives related to content that relates to the revised standards.** Contren Best Practices were added or changed.
- The reference list was updated.
- The Recommended Tools and Equipment list was updated to reflect the tool list for successful completion of Electrical Technology theory and content.

**Assessment**

Students will be assessed using the MS-CPAS2 Assessment, unless an alternative assessment is approved.

Students are assessed using the Electrical Technology MS-CPAS2 test. The MS-CPAS2 blueprint can be found at [http://www.rcu.msstate.edu/](http://www.rcu.msstate.edu/).

a. A student’s technical skill attainment for completion of the Career Certificate will be assessed utilizing the MSCPAS Career Certificate (Y1) assessment score.
b. A student’s technical skill attainment for the Technical Certificate and/or the Associate of Applied Science degree will be assessed utilizing the student’s MSCPAS Career Certificate (Y1) assessment and MSCPAS Technical Certificate (Y2) assessment.
c. **Timing of Y1 and Y2 Assessments:**
   a. A student may complete the Y1 assessment upon application for the Career Certificate.
   b. A student may complete the Y2 assessment upon application for the Technical Certificate or the Associate of Applied Science Degree (scores for the Y1 and Y2 assessments are averaged.)
   c. A student may complete both the Y1 and the Y2 assessment upon application for the Technical Certificate or the Associate of Applied Science Degree (scores for the Y1 and Y2 assessments are averaged.)

If there are questions regarding assessment of this program, please contact the Instructional Design Specialist at the Research and Curriculum Unit at 662.325.2510.

**Professional Learning**

It is suggested that instructors participate in professional learning related to the following concepts:
Computer skills for college credit – To learn more about computer skills instruction such as keyboading, word processing, PowerPoint, and so forth, please go to http://msvcc.blackboard.com/webapps/portal/frameset.jsp.

Computer skills for CEU credit

Differentiated instruction – To learn more about differentiated instruction, please go to http://www.paec.org/teacher2teacher/additional_subjects.html and click on Differentiated Instruction. Work through this online course and review the additional resources.

21st Century Skills – To learn more about computer skills instruction such as keyboading, word processing, PowerPoint, and so forth, please go to https://cia.rcu.msstate.edu/OnlinePD/.


Blackboard training

Contren Learning Series Certification – To learn more about Contren Learning Series Certification, please contact Mike Barkett at mike@mcef.net.

For the latest in online and yearly Connect training provided by the RCU Related Academics, please go to http://info.rcu.msstate.edu/.

Statewide articulations are subject to change as secondary http://www.ctb.com/ctb.com/control/main?p=home and postsecondary curriculum revisions occur—click on the TABE logo to learn about the most updated standards of the TABE exam.

All articulations listed in this document are effective as of July 1, 2008, unless otherwise noted.

Program Exceptions

No program exceptions exist at this time.

Articulation

Articulation credit from Secondary Construction – Electrical Career Pathway to Postsecondary Electrical Technology is available upon implementation of this curriculum by the college. Secondary students who have completed the articulated 2-year Secondary Construction – Electrician Career Pathway Courses may be awarded articulated college credit according to Mississippi Community College Board (MCCB) guidelines.

<table>
<thead>
<tr>
<th>SEC Program Articulated Secondary Course</th>
<th>PS Program Articulated Postsecondary Course</th>
<th>PS Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>S Electrician and Industrial Maintenance</td>
<td>PS Electrical Technology (CIP 46.0302)</td>
<td>ELT 1192 – 3 Fundamentals of Electricity</td>
</tr>
</tbody>
</table>
Statewide Guidelines on Articulated Credit

**Eligibility**

- **To be eligible for articulated credit, a student must:**
  - Complete the articulated Secondary Career and Technical Education Program
  - Score an 80 percent or higher on the Mississippi Career Planning and Assessment System (MS-CPAS2) in their secondary program of study

- **To be awarded articulated credit, a student must:**
  - Enroll in the community or junior college within 18 months of graduation
  - Articulated courses are transcribed immediately upon enrollment at a community college

**How MS-CPAS2 will be documented**

- The Research and Curriculum Unit of Mississippi State University will provide MS-CPAS2 scores, CIP Codes, district codes, secondary pathway name, and college numbers (identified by each student as colleges of interest) to Mississippi Department of Education to place on student transcripts.
- The Research and Curriculum Unit of Mississippi State University will provide MS-CPAS2 scores, CIP Codes, district codes and college number to the MCCB.
- The MCCB will forward the list of students eligible for articulated credit to the colleges.

**Transcripting of Articulated Credit**

- Articulated credit will be transcribed immediately upon college enrollment
- No grade will be given on the transcript for articulated courses, only hours granted will be transcribed (thus resulting in no change in quality points)

**Time Limit**

- MS-CPAS2 scores will be accepted to demonstrate competencies for up to 18 months after high school graduation
Cost

- No costs will be assessed on hours earned through articulated credit

Mississippi Workforce Advantage

The primary purpose of Career and Technical Education (CTE) and Workforce Education (WE) is to prepare present and future workers for high-wage, high-skill, and high-demand occupations in current or emerging professions. Additionally, CTE and WE programs aim to offer Mississippians opportunities that correspond to labor-market demands with multiple entrance and exit requirements that result in portable and stackable credentials for industry, certification-based training and coursework. A stackable credential is a career or college certificate program that builds, or “stacks,” with other certificate programs with the purpose of reengaging adults in school in order to prepare them for college and “next step”-level employment.

Through this collaborative initiative, CTE and WE curricula are developed in credit-bearing course hours and in WE modules to provide statewide standards for awarding college credit for technical, industry-recognized certificates. The designated WE curriculum module’s content articulates a specific number of college credits and aligns to all credit-bearing course competencies.

A secondary goal of MS Workforce Advantage is to increase student and participant enrollment, participation, and completion of credit-bearing programs. Strategies to promote transition to and success within the credit-bearing program are essential to the goal of helping students earn credentials, certificates, and degrees. Ongoing professional development for all stakeholders will be offered to ensure success.

A copy of the CTE to WE curriculum modules is located on the RCU website at http://www.rcu.msstate.edu/MCCB.aspx
Foreword

As the world economy continues to evolve, businesses and industries must adopt new practices and processes in order to survive. Quality and cost control, work teams and participatory management, and an infusion of technology are transforming the way people work and do business. Employees are now expected to read, write, and communicate effectively; think creatively, solve problems, and make decisions; and interact with each other and the technologies in the workplace. Vocational Career–technical programs must also adopt these practices in order to provide graduates who can enter and advance in the changing work world.

The curriculum framework in this document reflects these changes in the workplace and a number of other factors that impact local vocational career–technical programs. Federal and state legislation calls for articulation between high school and community college programs, integration of academic and vocational career skills, and the development of sequential courses of study that provide students with the optimum educational path for achieving successful employment. National skills standards, developed by industry groups and sponsored by the U.S. Department of Education and Labor, provide vocational career and technical educators with the expectations of employers across the United States. All of these factors are reflected in the framework found in this document.

Referenced throughout the courses of the curriculum are the 21st Century Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The need for these types of skills has been recognized for some time, and the 21st Century Skills is adapted in part from the 1991 report from the U.S. Secretary of Labor’s Commission on Achieving Necessary Skills (SCANS). Another important aspect of learning and working in the 21st century involves technology skills, and The International Society for Technology in Education, developers of the National Educational Technology Standards (NETS), were a strategic partner in the Partnership for 21st Century Skills.

Each postsecondary program of instruction consists of a program description and a suggested sequence of courses that focus on the development of occupational competencies. The MS-CPAS2 blueprints are based upon the suggested course sequences to allow for Career Certificate (Y1) and Technical Certificate (Y2) assessments for all exit options. Please refer to the blueprint online. Each vocational career–technical course in this sequence has been written using a common format that includes the following components:

- Course Name – A common name that will be used by all community and junior colleges in reporting students
• Course Abbreviation – A common abbreviation that will be used by all community and junior colleges in reporting students

• Classification – Courses may be classified as the following:
  o Vocational Career–technical core – A required vocational career–technical course for all students
  o Area of concentration (AOC) core – A course required in an area of concentration of a cluster of programs
  o Vocational Career–technical elective – An elective vocational career–technical course
  o Related academic course – An academic course that provides academic skills and knowledge directly related to the program area
  o Academic core – An academic course that is required as part of the requirements for an associate’s degree

• Description – A short narrative that includes the major purpose(s) of the course and the recommended number of hours of lecture and laboratory activities to be conducted each week during a regular semester

• Prerequisites – A listing of any courses that must be taken prior to or on enrollment in the course

• Corequisites – A listing of courses that may be taken while enrolled in the course

• Competencies and Suggested Objectives – A listing of the competencies (major concepts and performances) and the suggested student objectives that will enable students to demonstrate mastery of these competencies

The following guidelines were used in developing the program(s) in this document and should be considered in compiling and revising course syllabi and daily lesson plans at the local level:

• The content of the courses in this document reflects approximately 75% of the time allocated to each course. The remaining 25% of each course should be developed at the local district level and may reflect the following:
  o Additional competencies and objectives within the course related to topics not found in the state framework, including activities related to specific needs of industries in the community college district
  o Activities that develop a higher level of mastery on the existing competencies and suggested objectives
  o Activities and instruction related to new technologies and concepts that were not prevalent at the time the current framework was developed or revised
  o Activities that implement components of the Mississippi Tech Prep initiative, including integration of academic and vocational career–technical skills and coursework, school-to-work transition activities, and articulation of secondary and postsecondary vocational career–technical programs
  o Individualized learning activities, including work-site learning activities, to better prepare individuals in the courses for their chosen occupational areas
• Sequencing of the course within a program is left to the discretion of the local district. Naturally, foundation courses related to topics such as safety, tool and equipment usage, and other fundamental skills should be taught first. Other courses related to specific skill areas and related academics, however, may be sequenced to take advantage of seasonal and climatic conditions, resources located outside of the school, and other factors. Programs that offer an Associate of Applied Science Degree must include all of the required Career Certificate courses, Technical Certificate courses AND a minimum of 15 semester hours of General Education Core Courses. The courses in the General Education Core may be spaced out over the entire length of the program so that students complete some academic and Career Technical courses each semester. Each community college specifies the actual courses that are required to meet the General Education Core Requirements for the Associate of Applied Science Degree at their college. The following 2012 SACS standard applies.

• Programs that offer an Associate of Applied Science Section 2.7.3 For degree must include completion in associate programs, the component constitutes a minimum of 15 semester credit hour academic core. Specific courses to be taken within this core are to be determined by the local district. Minimum academic core courses are as follows:

  1. 3 semester credit hours Math/Science Elective
  2. 3 semester, or the equivalent. These credit hours Written Communications Elective
  3. 3 semester credit hours Oral Communications Elective
  4. 3 semester credit hours Humanities/Fine Arts Elective
  5. 3 semester credit hours Social/Behavioral Science Elective

It is recommended that courses in the academic core be spaced out over the entire length are to be drawn from and include at least one course from each of the program so that students complete some academic and vocational-technical courses each semester. Each community/junior college has the discretion to select the actual courses that are required to meet this academic core requirement.

• In instances where secondary programs are directly related to community and junior college programs, competencies and suggested objectives from the high school programs are listed as Baseline Competencies. These competencies and objectives reflect skills and knowledge that are directly related to the community and junior college vocational-technical program. In adopting the curriculum framework, each community and junior college is asked to give assurances that:

  1. Students who can demonstrate mastery of the Baseline Competencies do not receive duplicate instruction and
  2. Students who cannot demonstrate mastery of this content will be given the opportunity to do so.

• The roles of the Baseline Competencies are to:

  1. Assist community/junior college personnel in developing articulation agreements with high schools and
  2. Ensure that all community and junior college courses provide a higher level of instruction than their secondary counterparts.
The Baseline Competencies may be taught as special “Introduction” courses for 3–6 semester hours of institutional credit that will not count toward associate degree requirements. Community and junior colleges may choose to integrate the Baseline Competencies into ongoing courses in lieu of offering the “Introduction” courses or may offer the competencies through special projects or individualized instruction methods.

Technical elective courses have been included to allow community colleges and students to customize programs to meet the needs of industries and employers in their following areas: humanities/fine arts, social/behavioral sciences, and natural science/mathematics.

In order to provide flexibility within the districts, individual courses within a framework may be customized by doing the following:

- Adding new competencies and suggested objectives; to complement the existing competencies and suggested objectives in the program framework.
- Revising or extending the suggested objectives for individual competencies;
- Integrating baseline competencies from associated high school programs; or
- Adjusting the semester credit hours of a course to be up 1 hour or down 1 hour (after informing the State Board for Mississippi Community and Junior Colleges [SBCJC] or College Board [MCCB] of the change).

In addition, the curriculum framework as a whole may be customized by doing the following:

- Re-sequencing courses within the suggested course sequence; reflecting the new assessment format
- Developing and adding a new course that meets specific needs of industries and other clients in the community or junior college district (with SBCJC/MCCB approval); or
- Utilizing the technical elective options in many of the curricula to customize programs.
- Adding courses listed in the “Approved Career and Technical Electives List” as local certificate and degree completion requirements to meet specific needs of industries and other clients in the community. The “Approved Career and Technical Electives” are currently approved in the Uniform Course Numbering Book; therefore, MCCB approval is not required.
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Foreword

Program Description

Suggested Course Sequence

Electrical Technology Courses

- Residential/Light Commercial Wiring
- Commercial and Industrial Wiring
- Introduction to the National Electric Code
- AC and DC Circuits for Electrical Technology
- Drafting for Electrical
- Fundamentals of Electricity
- Electrical Power
- Motor Maintenance and Troubleshooting
- Branch Circuit and Service Entrance Calculations
- Blueprint Reading/Planning in Residential Installation
- Switching Circuits for Residential, Commercial, and Industrial Applications
- Estimating the Cost of an Electrical Installation
- Automated Manufacturing Controls for Electrical Technology
- Calibration and Measurement Principles used in the Electrical Industry
- Flexible Manufacturing Systems for Electrical Technology
- Fundamentals of Instrumentation
- Fundamentals of Robotics for Electrical Technology
- Industrial Hydraulics for Electrical Technology
- Industrial Pneumatics for Electrical Technology
- Industrial Robotics for Electrical Technology
- Servo Control Systems for Electrical Technology
- Motor Control Systems
- Solid State Devices and Circuits for Electrical Technology
- Data Acquisition and Communications
- Fundamentals of Fiber Optics for Electrical Technology
- Fundamentals of Data Communications for Electrical Technology
- Network Systems for Electrical Technology
- Satellite Systems
- Telephone Systems for Special Systems-Electrical Technology
- Principles of Hydraulics and Pneumatics
- Equipment Maintenance, Troubleshooting, and Repair
- Solid State Motor Control
- Programmable Logic Controllers
- Advanced Programmable Logic Controllers
- Special Project I, II
- Supervised Work Experience I, II
- Recommended Tools and Equipment
- Student Competency Profile for Electrical Technology
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<tr>
<td>ELT 1113</td>
<td>Residential/Light Commercial Wiring</td>
</tr>
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<td>ELT 1123</td>
<td>Commercial and Industrial Wiring</td>
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<td>ELT 1133</td>
<td>Introduction to the National Electric Code</td>
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<td>ELT 1144</td>
<td>AC and DC Circuits for Electrical Technology</td>
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<td>ELT 1213</td>
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<tr>
<td>ELT 1253</td>
<td>Branch Circuit and Service Entrance Calculations</td>
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<tr>
<td>ELT 1273</td>
<td>Switching Circuits for Residential, Commercial, and Industrial Applications</td>
</tr>
<tr>
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<td>Industrial Hydraulics for Electrical Technology</td>
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<td>ELT 1413</td>
<td>Motor Control Systems</td>
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<td>ELT 1434</td>
<td>Solid State Devices and Circuits for Electrical Technology</td>
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<td>ELT 1544</td>
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<td>ELT 1564</td>
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Program Description

The Postsecondary Electrical Technology program prepares individuals to install, operate, maintain, and repair electrical-energized systems. These systems include residential, commercial, and industrial wiring, DC and AC motors controls, and electrical distribution panels. The program offers extensive hands-on training in electrical troubleshooting and the development of problem-solving skills in industrial electrical procedures, programmable logic controllers, and process control.

Program Requirements

Electrical Technology is an articulated career and technical program designed to provide its students with technical skills. Entry into the program is based upon mastery of skills that are taught in secondary electrician programs. Students who do not possess such skills must complete additional course work in order to graduate from the program. The technical program consists of essential skills that may be obtained in a secondary program or at the community/junior college level and technical skills and academics that must be obtained at the community/junior college level.

This curriculum in Electrical Technology was developed using the competencies and objectives as developed by the National Center for Construction Education and Research (NCCER, 2008). Also, the National Electrical Code (2008) was used to ensure compliance with applicable codes.

The listing of tasks served as a baseline data for the revision of this curriculum. The task list used in this curriculum is based upon the following assumptions:

1. In all areas, appropriate theory, safety, and support instruction will be provided for each task. It is essential that all instruction has included use of appropriate tools, testing, and measuring instruments needed to accomplish certain tasks. It is also assumed that each student has received instruction to locate and use current reference materials from industry publications that present manufacturers’ recommended or required specifications and procedures for doing the various tasks.

2. The individual program should have written and detailed evaluation standards for each task covered in the curriculum. Learning progress of students should be monitored and evaluated against these stated standards. A system should be in place that informs all students of their progress throughout the program.

3. It is recognized that individual courses will differ across the technical programs. The development of appropriate learning activities and tests will be the responsibility of the individual program.

4. These standards require that tasks contained in the list be included in the program to validate that the program is meeting the needs of the electrical industry.
The curriculum for Electrical Technology is designed to serve as the core curriculum for approximately 75% of each course at the postsecondary level. The remaining 25% of each course is to be added at the local level based upon needs of students and area employers.

The technical program in Electrical Technology requires a minimum of 65 semester credit hours (sch) beyond the baseline competencies. Fifteen semester credit hours of academic core courses are included in this minimum. Certificate programs in Electrical Technology require a minimum of 36 semester credit hours.

Articulation

Articulation credit from Secondary Electrican and Industrial Maintenance to Postsecondary Electrical Technology will be awarded upon implementation of this curriculum by the college. The course to be articulated is Fundamentals of Electricity (ELT 1192-3) with the stipulations of passing the MS-CPAS2 according to SBCJC guidelines and an entrance/performance test.

The Electrical Technology program offers a Career certificate, Technical certificate and/or an Associate of Applied Science Degree.
Suggested Course Sequence*

Electrical Technology

Career Certificate Option

Baseline Competencies: A Career Certificate will be awarded upon completion of the required courses for the Career Certificate option in Electrical Technology**.

FIRST YEAR
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELT 1192–3</td>
<td>Fundamentals of Electricity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELT 1144***</td>
<td>AC and DC Circuits for Electrical Technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Technical Elective****</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELT 1113</td>
<td>Residential/Light Commercial Wiring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELT 1123</td>
<td>Commercial and Industrial Wiring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELT 1253</td>
<td>Branch Circuit and Service Entrance Calculations</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>18–19 sch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELT 1113</td>
<td>Residential/Light Commercial Wiring</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 1123</td>
<td>Commercial and Industrial Wiring</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 1144***</td>
<td>AC and DC Circuits for Electrical</td>
<td>4 sch: 2 hr lecture, 4 hr lab</td>
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<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Credits</td>
<td>Schedule</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------------------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>*ELT 1192-3</td>
<td>Fundamentals of Electricity</td>
<td>2-3 sch</td>
<td>1 hr lecture, 2-4 hr lab</td>
</tr>
<tr>
<td>*ELT 1213</td>
<td>Electrical Power</td>
<td>3 sch</td>
<td>2 hr. lecture, 2 hr. lab</td>
</tr>
<tr>
<td>*ELT 1253</td>
<td>Branch Circuit and Service Entrance Calculations</td>
<td>3 sch</td>
<td>2 hr lecture, 2 hr. lab</td>
</tr>
<tr>
<td>*ELT 1263</td>
<td>Blueprint Reading/Planning in Residential Installation</td>
<td>3 sch</td>
<td>2 hr lecture, 2 hr lab</td>
</tr>
<tr>
<td>*ELT 1413</td>
<td>Motor Control Systems</td>
<td>3 sch</td>
<td>2 hr lecture, 2 hr lab</td>
</tr>
<tr>
<td></td>
<td>Approved Career Technical Electives</td>
<td></td>
<td>5 -6 sch</td>
</tr>
<tr>
<td></td>
<td>Total Semester Credit Hours for a Career Certificate</td>
<td></td>
<td>30 sch</td>
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</tbody>
</table>

* Students who lack entry level skills in math, English, science, and so forth will be provided related studies.

** Baseline competencies are taken from the high school Electrician program. Students who can document mastery of these competencies should not receive duplicate instruction. Students who cannot demonstrate mastery will be required to do so.

*** + DC Circuits (EET 1114) and AC Circuits (EET 1123) may be taken instead of AC and DC Circuits for Electrical Technology (ELT 1144), and the 3 hour elective.
***TECHNICAL ELECTIVES

*These course competencies will be assessed in the MSCPAS2 Career certificate (Y1) assessment.

Students who lack entry level skills in math, English, science, etc. will be provided related studies.
Suggested Course Sequence  
Electrical Technology

Technical Certificate Option

A Technical Certificate will be awarded upon completion of all required Career Certificate courses AND the following required Technical Certificate courses in the Electrical Technology program.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>*ELT 2113-4</td>
<td>Equipment Maintenance, Troubleshooting, and Repair</td>
<td>3-4 sch: 1 hr lecture, 4-6 hr lab</td>
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</tr>
<tr>
<td>*ELT 2424</td>
<td>Solid State Motor Control</td>
<td>4 sch: 2 hr lecture, 4 hr lab</td>
<td></td>
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<tr>
<td>*ELT 2613</td>
<td>Programmable Logic Controllers</td>
<td>3 sch: 1 hr. lecture, 4 hr. lab</td>
<td></td>
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<td></td>
<td>Approved Career Technical Electives</td>
<td>4-5 sch</td>
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<td></td>
<td>Total Semester Credit Hours for a Technical Certificate</td>
<td>45 sch</td>
<td></td>
</tr>
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</table>

*These course competencies will be assessed in the MSCPAS2 Technical certificate (Y2) assessment.

3 sch | Introduction to the National Electric Code (ELT 1133)

4 sch | Solid State Devices and Circuits for Electrical Technology (ELT 1434)

3 sch | Digital Electronics (EET 1214)

3 sch | Data Acquisition and Communications (ELT 1513)

3 sch | Fundamentals of CAD (DDT 1313/ELT)

3 sch | Fundamentals of Fiber Optics for Electrical Technology (ELT 1523)

3 sch | Fundamentals of Data Communications for Electrical Technology (ELT 1523)
<table>
<thead>
<tr>
<th>Sch</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>3</td>
<td>Drafting for Electrical Technology</td>
<td>(EET 1713)</td>
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<tr>
<td>3</td>
<td>Drafting for Electronic/Electrical Technology</td>
<td>(EET 1713)</td>
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<tr>
<td>3</td>
<td>Branch Circuit and Service Entrance Calculations</td>
<td>(ELT 1253)</td>
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<tr>
<td>3</td>
<td>Blueprint Reading/Planning in Residential Installation</td>
<td>(ELT 1263)</td>
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<tr>
<td>3</td>
<td>Automated Manufacturing Control for Electricity</td>
<td>(ELT 1313)</td>
</tr>
<tr>
<td>4</td>
<td>Calibration and Measurement Principles used in the Electrical Industry</td>
<td>(ELT 1324)</td>
</tr>
<tr>
<td>4</td>
<td>Network Systems for Electrical Technology</td>
<td>(ELT 1544)</td>
</tr>
<tr>
<td>3</td>
<td>Satellite Systems</td>
<td>(ELT 1553)</td>
</tr>
<tr>
<td>4</td>
<td>Telephone Systems for Special Systems Electrical Technology</td>
<td>(ELT 1564)</td>
</tr>
<tr>
<td>4</td>
<td>Principles of Hydraulics and Pneumatics</td>
<td>(IMM 1314/ELT 1614)</td>
</tr>
<tr>
<td>4</td>
<td>Equipment Maintenance, Troubleshooting, and Repair</td>
<td>(IMM 2114/ELT 2114)</td>
</tr>
<tr>
<td>3</td>
<td>Advanced Programmable Logic Controllers</td>
<td>(ELT 2623)</td>
</tr>
<tr>
<td>3</td>
<td>Approved Computer Programming Language†</td>
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<tr>
<td>1–6</td>
<td>Supervised Work Experience I, II</td>
<td>[ELT 292(1–6), ELT 294(1–6)]</td>
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<tr>
<td>1–3</td>
<td>Special Project I, II</td>
<td>[ELT 291(1–3), ELT 293(1–3)]</td>
</tr>
<tr>
<td>3</td>
<td>Estimating the Cost of a Residential</td>
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</tbody>
</table>
Industrial Hydraulics for Electrical Technology (ELT 1363)

3-sch

Industrial Pneumatics for Electrical Technology (ELT 1373)

3-sch

Industrial Robotics (ELT 1383)

3-sch

Servo Control Systems (ELT 1393)

3-sch

Fundamentals of Fiber Optics (EET 1343)


3-sch

Fundamentals of Instrumentation (ELT 1343)
3 sch  Computer Fundamentals for Electronics/Electricity (EET 1613)†

3 sch  Fundamental s of Microcomputer Applications (CPT 1113)†

*****ELECTIVES

Any instructor-approved related technical or academic course
Suggested Course Sequence
Electrical Technology

Associate of Applied Science Degree Option

Baseline Competencies for Electrical Technology**

FIRST YEAR

To receive the Associate of Applied Science Degree in Electrical Technology, a student must complete all of the required Career Certificate courses, Technical Certificate courses AND a minimum of 15 semester hours of General Education Core Courses. The courses in the General Education Core may be spaced out over the entire length of the program so that students complete some academic and Career Technical courses each semester. Each community college specifies the actual courses that are required to meet the General Education Core Requirements for the Associate of Applied Science Degree at their college. The following 2012 SACS standard applies.

Section 2.7.3 For degree completion in associate programs, the component constitutes a minimum of 15 semester hours or the equivalent. These credit hours are to be drawn from and include at least one course from each of the following areas: humanities/fine arts, social/behavioral sciences, and natural science/mathematics.

A student must complete the following minimum credit requirements for the AAS Degree Option:

Career Certificate 30 credits minimum
Technical Certificate 15 credits minimum
General Education Core Courses 15 credits minimum
2–3 sch Fundamentals of Electricity (ELT 1192–1193)

4 sch AC and DC Circuits

Total Semester Credit Hours for Electrical Technology (ELT 1144)***

3 sch Technical Elective****

3 sch Residential/Light Commercial Wiring (ELT 1113)

3 sch Electrical Power (ELT 1213)

3 sch Math/the Associate of Applied Science Elective

3–6 sch Elective*****

15–18 sch 60 credits minimum hours earned as a compilation of Career, Technical, and Academic credit hours.

SECOND YEAR

Approved Career–Technical elective courses have been included to allow community colleges and students to customize programs to meet the needs of industries and employers in their area.

In order to provide flexibility within the districts, individual courses within a framework may be customized by doing the following:

- Adding new competencies and suggested objectives to complement the existing competencies and suggested objectives in the program framework.
- Revising or extending the suggested objectives for individual competencies.
- Adjusting the semester credit hours of a course to be up 1 hour or down 1 hour (after informing the Mississippi Community College Board [MCCB] of the change).

In addition, the curriculum framework as a whole may be customized by doing the following:

- Sequencing courses within the suggested course sequence to reflecting the new assessment format.
- Developing and adding a new course that meets specific needs of industries and other clients in the community or junior college district (with MCCB approval).
- Adding courses listed in the “Approved Career and Technical Electives List” as local certificate and degree completion requirements to meet specific needs of industries and other clients in the community. The “Approved Career and Technical Electives” are currently approved in the Uniform Course Numbering Book; therefore, MCCB approval is not required.
## APPROVED CAREER AND TECHNICAL ELECTIVES
### for
#### Electrical Technology

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPT 1113</td>
<td>Fundamentals of Microcomputer Applications†</td>
<td>3 sch:</td>
<td>See Appropriate Program Description</td>
</tr>
<tr>
<td>CTE 1143</td>
<td>Fundamentals of Construction and Manufacturing</td>
<td>(3 sch: 2 hr. lecture, 2 hr. lab)</td>
<td></td>
</tr>
<tr>
<td>CTE 1153</td>
<td>Computational Methods for Career and Technical Education</td>
<td>(3 sch: 2-hr lecture, 2-hr lab)</td>
<td></td>
</tr>
<tr>
<td>CTE 1163</td>
<td>Introduction to Sustainable and Renewable Energy</td>
<td>(3 sch: 2-hr lecture, 2-hr lab)</td>
<td></td>
</tr>
<tr>
<td>EET 1214</td>
<td>Digital Electronics</td>
<td>3 sch:</td>
<td>See Appropriate Program Description</td>
</tr>
<tr>
<td>EET 1334</td>
<td>Solid State Devices and Circuits</td>
<td>3 sch:</td>
<td>See Appropriate Program Description</td>
</tr>
<tr>
<td>EET 1613</td>
<td>Computer Fundamentals for Electronics/Electricity†</td>
<td>3 sch:</td>
<td>See Appropriate Program Description</td>
</tr>
<tr>
<td>EET 2423</td>
<td>Fundamentals of Fiber Optics</td>
<td>3 sch:</td>
<td>See Appropriate Program Description</td>
</tr>
<tr>
<td>Credits</td>
<td>Course Code</td>
<td>Course Title</td>
<td>Schedule</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
<td>--------------</td>
<td>----------</td>
</tr>
<tr>
<td>3 sch</td>
<td>ELT 2613</td>
<td>Programmable Logic Controllers (ELT 2613)</td>
<td></td>
</tr>
<tr>
<td>4 sch</td>
<td>ELT 2424</td>
<td>Solid State Motor Control (ELT 2424)</td>
<td></td>
</tr>
<tr>
<td>3 sch</td>
<td></td>
<td>Computer Related Elective</td>
<td></td>
</tr>
<tr>
<td>3 sch</td>
<td></td>
<td>Written Communications Elective</td>
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<tr>
<td>3 sch</td>
<td></td>
<td>Humanities/Fine Arts Elective</td>
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<tr>
<td>16 sch</td>
<td>ELT 1133</td>
<td>Introduction to the National Electric Code</td>
<td>1-9 sch Technical Electives</td>
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<tr>
<td>3 sch</td>
<td></td>
<td>Oral Communications Elective</td>
<td>3 sch Social/Behavioral Science Elective</td>
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<tr>
<td>7-15 sch</td>
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<td>2 hr lecture, 2 hr lab</td>
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<tr>
<td>16 sch</td>
<td>ELT 1153</td>
<td>Computational Methods for Electrical Technology</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
</tr>
<tr>
<td>ELT 1163</td>
<td></td>
<td>Drafting for Electrical Technology</td>
<td>3 sch: 1 hr lecture, 4 hr lab</td>
</tr>
<tr>
<td>ELT 1223</td>
<td></td>
<td>Motor Maintenance and Troubleshooting</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
</tr>
<tr>
<td>ELT 1253</td>
<td></td>
<td>Branch Circuit and Service Entrance Calculations</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
</tr>
<tr>
<td>ELT 1263</td>
<td></td>
<td>Blueprint Reading/Planning in Residential Installation</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
</tr>
<tr>
<td>ELT 1273</td>
<td></td>
<td>Switching Circuits for Residential, Commercial, and Industrial Applications</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
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<tr>
<td>ELT 1283</td>
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<td>Estimating the Cost of a Residential Installation</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
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<tr>
<td>ELT 1313</td>
<td></td>
<td>Automated Manufacturing Control for Electricity</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Credits</td>
<td>Lectures</td>
</tr>
<tr>
<td>------------</td>
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<tr>
<td>ELT 1324</td>
<td>Calibration and Measurement Principles used in the Electrical Industry</td>
<td>4</td>
<td>3 hr</td>
</tr>
<tr>
<td>ELT 1334</td>
<td>Flexible Manufacturing Systems for Electrical Technology</td>
<td>4</td>
<td>2 hr</td>
</tr>
<tr>
<td>ELT 1343</td>
<td>Fundamentals of Instrumentation</td>
<td>3</td>
<td>2 hr</td>
</tr>
<tr>
<td>ELT 1353</td>
<td>Fundamentals of Robotics for Electrical Technology</td>
<td>3</td>
<td>2 hr</td>
</tr>
<tr>
<td>ELT 1363</td>
<td>Industrial Hydraulics for Electrical Technology</td>
<td>3</td>
<td>2 hr</td>
</tr>
<tr>
<td>ELT 1373</td>
<td>Industrial Pneumatics for Electrical Technology</td>
<td>3</td>
<td>2 hr</td>
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<tr>
<td>ELT 1383</td>
<td>Industrial Robotics for Electrical Technology</td>
<td>3</td>
<td>2 hr</td>
</tr>
<tr>
<td>ELT 1393</td>
<td>Servo Control Systems for Electrical Technology</td>
<td>3</td>
<td>2 hr</td>
</tr>
<tr>
<td>ELT 1434</td>
<td>Solid State Devices and Circuits for Electrical Technology</td>
<td>4</td>
<td>2 hr</td>
</tr>
<tr>
<td>ELT 1513</td>
<td>Data Acquisition and Communications</td>
<td>3</td>
<td>2 hr</td>
</tr>
<tr>
<td>ELT 1523</td>
<td>Fundamentals of Fiber Optics for Electrical Technology</td>
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<td>2 hr</td>
</tr>
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<td>ELT 1533</td>
<td>Fundamentals of Data Communications for Electrical Technology</td>
<td>3</td>
<td>2 hr</td>
</tr>
<tr>
<td>ELT 1544</td>
<td>Network Systems for Electrical Technology</td>
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<td>2 hr</td>
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<tr>
<td>ELT 1553</td>
<td>Satellite Systems</td>
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<td>1 hr</td>
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<tr>
<td>ELT 1564</td>
<td>Telephone Systems for Special Systems Electrical Technology</td>
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<td>3 hr</td>
</tr>
<tr>
<td>ELT 1614</td>
<td>Principles of Hydraulics and Pneumatics</td>
<td>3-4</td>
<td>1 hr</td>
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<td>ELT 2113-4</td>
<td>Equipment Maintenance, Troubleshooting, and Repair</td>
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<td>1 hr</td>
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<td>ELT 2213</td>
<td>Introduction to Sustainable and Renewable Energy</td>
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<td>2 hr</td>
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<td>ELT 2613</td>
<td>Programmable Logic Controllers</td>
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<td>2 hr</td>
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<td>ELT 2623</td>
<td>Advanced Programmable Logic Controllers</td>
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<tr>
<td>IMM 1933</td>
<td>Manufacturing Skills</td>
<td>3 sch: See Appropriate Program Description</td>
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<tr>
<td>ELT 291(1–3)</td>
<td>Special Project I</td>
<td>3 sch: 2–6 hr. lab</td>
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<tr>
<td>ELT 293(1–3)</td>
<td>Special Project II</td>
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<td>ELT 292(1–6)</td>
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<tr>
<td>ELT 294(1–6)</td>
<td>Supervised Work Experience II</td>
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<td>WBL 191(1-3)</td>
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<td>1-3 sch: 3-9 hr. externship</td>
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<td>WBL 192(1-3)</td>
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<td>WBL 291(1-3)</td>
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</table>

*Other instructor approved electives that are listed in the MCCB approved CTE or Academic Uniform Course Numbering document.*

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*Students who lack entry level skills in math, English, science, and so forth will be provided related studies.*

**Baseline competencies are taken from the high school Electrician program. Students who can document mastery of these competencies should not receive duplicate instruction. Students who cannot demonstrate mastery will be required to do so.*

***DC Circuits (EET 1114) and AC Circuits (EET 1123) may be taken instead of AC and DC Circuits for Electrical Technology (ELT 1144).***
### TECHNICAL ELECTIVES

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<thead>
<tr>
<th>Schs</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>3</td>
<td>Introduction to the National Electric Code (ELT 1133)</td>
</tr>
<tr>
<td>4</td>
<td>Digital Electronics (EET 1214)</td>
</tr>
<tr>
<td>3</td>
<td>Fundamentals of CAD (DDT 1313/ELT 1153)</td>
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<tr>
<td>3</td>
<td>Drafting for Electrical Technology (1163)</td>
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<tr>
<td>3</td>
<td>Drafting for Electronic/Electrical Technology (EET 1713)</td>
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<tr>
<td>3</td>
<td>Branch Circuit and Service Entrance Calculations (ELT 1253)</td>
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<tr>
<td>3</td>
<td>Blueprint Reading/Planning in Residential Installation (ELT 1263)</td>
</tr>
<tr>
<td>3</td>
<td>Automated Manufacturing Control for Electricity (ELT 1313)</td>
</tr>
<tr>
<td>4</td>
<td>Calibration and Measurement Principles used in the Electrical Industry (ELT 1324)</td>
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<td>4</td>
<td>Flexible Manufacturing Systems for Electrical Technology (ELT 1334)</td>
</tr>
<tr>
<td>3</td>
<td>Fundamentals of Instrumentation (ELT 1343)</td>
</tr>
<tr>
<td>3</td>
<td>Fundamentals of Robotics for Electrical Technology (ELT 1353)</td>
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<tr>
<td>3</td>
<td>Industrial Hydraulics for Electrical Technology (ELT 1363)</td>
</tr>
<tr>
<td>3</td>
<td>Industrial Pneumatics for Electrical Technology (ELT 1373)</td>
</tr>
<tr>
<td>3</td>
<td>Industrial Robotics (ELT 1383)</td>
</tr>
<tr>
<td>3</td>
<td>Servo Control Systems (ELT 1393)</td>
</tr>
<tr>
<td>4</td>
<td>Solid State Devices and Circuits for Electrical Technology (ELT 1434)</td>
</tr>
<tr>
<td>3</td>
<td>Data Acquisition and Communications (ELT 1513)</td>
</tr>
<tr>
<td>3</td>
<td>Fundamentals of Fiber Optics for Electrical Technology (ELT 1523)</td>
</tr>
<tr>
<td>3</td>
<td>Fundamentals of Data Communications for Electrical Technology (ELT 1533)</td>
</tr>
<tr>
<td>4</td>
<td>Network Systems for Electrical Technology (ELT 1544)</td>
</tr>
<tr>
<td>3</td>
<td>Satellite Systems (ELT 1553)</td>
</tr>
<tr>
<td>4</td>
<td>Telephone Systems for Special Systems Electrical Technology (ELT 1564)</td>
</tr>
<tr>
<td>4</td>
<td>Principles of Hydraulics and Pneumatics (IMM-1314/ELT-1614)</td>
</tr>
<tr>
<td>4</td>
<td>Equipment Maintenance, Troubleshooting, and Repair (IMM 2114/ELT 2114)</td>
</tr>
<tr>
<td>3</td>
<td>Advanced Programmable Logic Controllers (ELT 2623)</td>
</tr>
<tr>
<td>3</td>
<td>Approved Computer Programming Language†</td>
</tr>
<tr>
<td>1–3</td>
<td>Special Project I, II [ELT 291(1–3), ELT 293(1–3)]</td>
</tr>
<tr>
<td>1–6</td>
<td>Supervised Work Experience I, II [ELT 292(1–6), ELT 294(1–6)]</td>
</tr>
<tr>
<td>3</td>
<td>Estimating the Cost of a Residential Installation (ELT 1283)</td>
</tr>
<tr>
<td>1–3</td>
<td>Work-Based Learning I, II, III, IV, V, and</td>
</tr>
</tbody>
</table>
3 sch—Fundamentals of Fiber Optics (EET 2423)

3 sch—Computer Fundamentals for Electronics/Electricity (EET 1613)†

3 sch—Fundamentals of Microcomputer Applications (CPT 1113)†

*****ELECTIVES

Any instructor-approved related technical or academic course

† May be selected as computer related elective
**Course Name:** Residential/Light Commercial Wiring

**Course Abbreviation:** ELT 1113

**Classification:** Vocational – Career, Technical, and Associate Degree Core

**Description:** Advanced skills related to the wiring of multifamily and small commercial buildings. Includes instruction and practice in service-entrance installation, specialized circuits, and the use of commercial raceways (3 sch: 2-hr lecture, 2-hr lab).

**Pre/Corequisites:**
- **Prerequisite:** Fundamentals of Electricity (ELT 1192-3) or by permission of instructor

### Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>1.</th>
<th>Read and utilize drawings of a structure.</th>
<th>DOK 3, ELT1.10, ELT1.11</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Identify residential and commercial symbols used on drawings.</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Calculate feeder lead for single, multifamily, and small commercial buildings.</td>
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<tr>
<td>c.</td>
<td>Select the proper size and type of wire, conduit, fittings, load protection devices, and boxes for residential and commercial installation.</td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>Develop a cost estimate for an assigned project to include supply and labor costs.</td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td>Interpret a residential/commercial drawing and specifications to determine tools, equipment, and supplies needed for the job.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2.</th>
<th>Simulate wiring a residence and/or commercial building according to the current NEC and local codes.</th>
<th>DOK2, ELT1.6, ELT1.11, ELT2.6, ELT2.10</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Draw a sketch, and install a service entrance and load, center, main branch circuits, feeder circuits, appliance circuits, and various switching circuits, according to current NEC and local codes.</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Draw a sketch, and install specialized circuits to include telephone, low voltage, and remote control systems.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3.</th>
<th>Discuss current protective devices, load centers, panel boards, and safety switches.</th>
<th>DOK2, ELT1.6, ELT1.9, ELT1.11, ELT2.6, ELT2.10</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>List five types of over current protective devices and their characteristics.</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>List installations that require AFCI/GFCI circuits.</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>Identify types of safety enclosures and configurations.</td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>Draw and label parts of a breaker load center.</td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td>Demonstrate safety rules for working near or at load centers, panel boards, and safety switches by use of lockout/tagout procedures.</td>
<td></td>
</tr>
</tbody>
</table>
STANDARDS

National Center for Construction Education and Research Standards

ELT1.7 Introduction to the National Electrical Code
ELT1.6 Device Boxes (Module 26106.11)
ELT1.9 Conductors and Cables (Module 26109-11)
ELT1.10 Basic Electrical Construction Drawings (Module 26110-11)
ELT1.11 Residential Electrical Services (Module 26111-11)

Related Academic Standards

C1 Interpret written material.
C2 Interpret visual materials (maps, charts, graphs, tables, etc.).
C3 Listen, comprehend, and take appropriate actions.
C4 Access, organize, and evaluate information.
C5 Use written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.
C6 Communicate ideas and information effectively using various oral and written forms for a variety of audiences and purposes.
M1 Relate number relationships, number systems, and number theory.
M2 Explore patterns and functions.
M4 Explore the concepts of measurement.
M5 Explore the geometry of one-, two-, and three-dimensions.
M7 Apply mathematical methods, concepts, and properties to solve a variety of real-world problems.
S8 Apply concepts related to the scientific process and method to include safety procedures for classroom and laboratory; use and care of scientific equipment; interrelationships between science, technology, and society; and effective communication of scientific results in oral, written, and graphic form.
21st Century Skills

CS1——Global Awareness
CS2——Financial, Economic, and Business Literacy
CS3——Civic Literacy
CS4——Information and Communication Skills
CS5——Thinking and Problem-Solving Skills
CS6——Interpersonal and Self-Directional Skills

National Educational ELT2.6——Conductor Installations (Module 26206-11)
ELT2.10——Circuit Breakers and Fuses (Module 26210-11)
Course Name: Commercial and Industrial Wiring

Course Abbreviation: ELT 1123

Classification: Career, Technical, and Associate Degree Core

Description: Instruction and practice in the installation of commercial and industrial electrical services including the types of conduit and other raceways, NEC code requirements, and three-phase distribution networks. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3), Residential/Light Commercial Wiring (ELT 1113), or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
<th>DOK, ELT</th>
<th>1. Apply general safety rules and current NEC and local codes.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3, ELT1.2, ELT1.5</td>
<td>a. Explain and demonstrate safety rules and regulations for working near or on load centers and safety switches.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Explain and demonstrate the ability of safe lifting and work habits.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Identify the code requirements for industrial and commercial locations.</td>
</tr>
<tr>
<td>2. Install and maintain raceways, conduit, and fittings.</td>
<td>DOK2, ELT2.4, ELT1.8</td>
<td>a. Identify types of raceways, conduit, and fittings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Apply usage of raceways, conduit, and fittings as required by electrical codes.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Demonstrate the use of mechanical and hydraulic conduit benders to make specified bends to different sizes and types of conduit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Identify other types of raceways and their associated bodies.</td>
</tr>
<tr>
<td>3. Explain different types of three-phase service entrances, metering devices, main panels, raceways or ducts, subpanels, feeder circuits, and branch circuits according to electrical codes.</td>
<td>DOK2, ELT3.8, ELT3.6</td>
<td>a. Explain the codes NEC and local codes) for the installation of a three-phase service entrance.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Explain safety precautions to be used when installing a three-phase service entrance.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Construct a sketch to install a three-phase service entrance.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Explain terms associated with a three-phase service entrance from codes and industry terminology.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e. Identify components of a three-phase service entrance.</td>
</tr>
<tr>
<td>4. Prepare a job estimate including supplies and labor costs.</td>
<td>DOK2, ELT1.10</td>
<td>a. Compute the local labor cost for a given job.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Determine amount of supplies for a given job.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Compute the cost of supplies for a given job.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Justify in writing the total cost for a given job.</td>
</tr>
</tbody>
</table>

STANDARDS

National Center for Construction Education and Research Standards
<table>
<thead>
<tr>
<th>Module</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELT1.2</td>
<td>Electrical Safety (Module 26102-11)</td>
</tr>
<tr>
<td>ELT1.5</td>
<td>Introduction to the National Electrical Code (Module 26105.11)</td>
</tr>
<tr>
<td>ELT1.8</td>
<td>Raceways and Fittings (Module 26108.11)</td>
</tr>
<tr>
<td>ELT1.10</td>
<td>Basic Electrical Construction Drawings (Module 26110-11)</td>
</tr>
<tr>
<td>ELT2.4</td>
<td>Conduit Bending (Module 26204-11)</td>
</tr>
<tr>
<td>ELT3.6</td>
<td>Distribution Equipment (Module 26306-11)</td>
</tr>
<tr>
<td>ELT3.8</td>
<td>Commercial Electrical Services (Module 26308-11)</td>
</tr>
</tbody>
</table>
Course Name: Introduction to the National Electric Code

Course Abbreviation: ELT 1133

Classification: Career, Technical, and Associate Degree Elective

Description: This is a course in the layout, format, rules, and regulations set forth in the National Electric Code. Emphasis is placed on developing the student’s ability to find information in the National Electric Code and applying that information in real-world applications. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: None

Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>Competency</th>
<th>Suggested Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Use the NEC as a reference manual to locate information and give a reference of where the information can be found. DOK3, ELT1.5</td>
</tr>
<tr>
<td>a.</td>
<td>Find and interpret the requirements for installing various electrical equipment and conductors in dry, damp, and wet locations.</td>
</tr>
<tr>
<td>b.</td>
<td>Calculate the size of the current carry conductors needed to supply a circuit.</td>
</tr>
<tr>
<td>c.</td>
<td>Calculate the current carrying capabilities of conductors with variances in the number of conductors in a raceway and changes in ambient temperature.</td>
</tr>
<tr>
<td>d.</td>
<td>Calculate the size of service conductors for the ungrounded, grounded, and grounding conductor.</td>
</tr>
<tr>
<td>e.</td>
<td>Calculate the number of specific current carry conductors that can be installed in a raceway.</td>
</tr>
</tbody>
</table>

STANDARDS

National Center for Construction Education and Research Standards

ELT1.5 Introduction to the National Electrical Code (Module 26105.11)
Course Name: AC and DC Circuits for Electrical Technology Standards for Students

T1 — Basic operations and concepts

T3 — Technology productivity tools

T4 — Course Abbreviation: ELT 1144

Classification: Career, Technical, and Associate Degree Core

Description: Principles and theories associated with AC and DC circuits used in the electrical trades. Includes the study of electrical circuits, laws and formulas, and the use of test equipment to analyze AC and DC circuits (4 sch: 2-hr lecture, 4-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3) or by permission of instructor

Competencies and Suggested Objectives

1. Demonstrate and practice general safety procedures in the school and work site environments.  
   a. Apply relevant and appropriate safety techniques.
   b. Demonstrate and comply with relevant OSHA safety standards.

2. Demonstrate and apply a basic electrical circuit.  
   a. Write numbers in scientific and engineering notation.
   b. Perform mathematical manipulations with numbers expressed in engineering notation.
   c. Explain the basic structure of matter to include the atom and element.
   d. Explain the laws of electrical charge.
   e. Differentiate among the characteristics of conductors, semiconductors, and insulators.
   f. Demonstrate the ability to determine resistor types, value, tolerance, and power rating.
   g. Demonstrate proper techniques for measuring resistance.
   h. Discuss methods of generating electricity.
   i. Explain theories of current flow including electron and conventional method.
   j. Demonstrate principles of and operation of batteries.
   k. Explain and demonstrate measurement of resistance of conductors and insulators and the computation of conductance.

3. Demonstrate the meaning of and relationships among and between voltage, current, resistance, and power in AC and DC circuits.  
   a. Explain the relationship between voltage, current, and resistance in AC and DC circuits.
   b. State three equations used to express Ohm’s law.
   c. Analyze circuit parameters using Ohm’s law.
   d. Explain how power is developed in a circuit.
   e. State three forms of power equations.
   f. Demonstrate techniques for determining a power.
   g. Explain proper techniques for connecting a voltmeter to measure voltage.
   h. Explain proper techniques for connecting current meter to measure current.
<p>| | | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>i.</td>
<td>Measure voltage.</td>
<td>i. Measure voltage.</td>
</tr>
<tr>
<td>j.</td>
<td>Measure resistance.</td>
<td>j. Measure resistance.</td>
</tr>
<tr>
<td>k.</td>
<td>Measure current.</td>
<td>k. Measure current.</td>
</tr>
</tbody>
</table>

4. Analyze and evaluate the parameters of AC and DC series circuits.  
   a. Identify series circuits.  
   b. Compute total resistance of a series circuit.  
   c. Compute current in a series circuit using Ohm’s law.  
   d. Explain why current is the same at all points in a series circuit.  
   e. State and apply Kirchoff’s Voltage Law in analysis of series circuits.  
   f. Explain why series circuits are known as a voltage divider.  
   g. Compute voltage drops in a series circuit using Ohm’s law.  
   h. Compute the power developed by each resistor and the total power of a series circuit.  
   i. Explain the difference between series-aiding and series-opposing voltage sources.  
   j. Construct, analyze, and troubleshoot a series circuit.  

5. Analyze and evaluate the parameters of AC and DC parallel circuits.  
   a. Identify parallel circuits.  
   b. Compute total resistance of a parallel circuit.  
   c. Utilize Ohm’s law to solve circuit parameters of parallel DC circuit.  
   d. Explain why voltage is the same across all branches of a parallel circuit.  
   e. State and apply Kirchoff’s Current Law in the analysis of parallel circuit.  
   f. Explain why a parallel circuit is a current divider.  
   g. Compute branch currents in a parallel resistive circuit using the current divider equation.  

6. Analyze and evaluate the parameters of AC and DC series-parallel circuit.  
   c. Analyze series-parallel circuits for the current through and the voltage across each component.  
   d. Construct, analyze, and troubleshoot a series-parallel circuit.  

7. Analyze inductive and capacitive reactance in series and parallel circuits.  
   a. Calculate inductive reactance \( X_L \) using Ohm’s law or the inductive reactance formula when signal frequency and inductance are known.  
   b. Solve for signal frequency when inductance and inductive reactance are known or inductance when frequency and inductive reactance are known.  
   c. Calculate capacitive reactance \( X_C \) using Ohm’s law or the capacitive reactance formula when signal frequency and capacitance are known.  
   d. Solve for signal frequency when capacitance and capacitive reactance are known or capacitance when frequency and capacitive reactance are known.  
   e. Calculate all voltages and currents in series and parallel capacitive and inductive circuits.  

8. Analyze transformer voltage, current, impedance transformations, and applications.  
   a. Explain how mutual inductance affects transformer action.
b. Calculate primary and secondary transformer voltage and current as related to the transformer’s turns ratio.
c. Explain the theory of reflected impedance between the primary and secondary, or secondary’s of transformers.
d. Calculate reflected impedance given a transformer turns ratio and secondary load impedance.
e. Explain various transformer ratings, such as voltage, current, power, impedance, frequency, and efficiency.
f. Explain various transformer losses such as winding losses and core losses.
g. Discuss a variety of transformer types and applications.
h. Construct transformer circuits, and measure voltages and currents as calculated.
i. Troubleshoot a transformer using an ohmmeter and/or voltmeter.

STANDARDS

National Center for Construction Education and Research Standards

ELT1.2 Electrical Safety (Module 26102-11)
ELT1.3 Introduction to Electrical Circuits (Module 26103.11)
ELT1.4 Electrical Theory (Module 26104.11)
ELT1.12 Electrical Test Equipment (Module 26112-11)
ELT2.1 Alternating Current (Module 26201-11)
Course Name: Computational Methods for Electrical Technology communications tools

Course Abbreviation: ELT 1153

Classification: Career, Technical, and Associate Elective

Description: Study of computational skills required for the development of accurate design and drafting methods used in the electrical technology profession. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: None

Competencies and Suggested Objectives

1. Demonstrate various measurement methods.
   a. Measure distances, including metric and English measurements.
   b. Measure angles, including decimal degrees and degrees, minutes, and seconds.

2. Apply industry data.
   a. Interpret graphs and charts.
   b. Manipulate gathered information.

3. Analyze complex geometric shapes.
   a. Calculate area using metric and English systems.
   b. Calculate volume using metric and English systems.
   c. Solve geometric construction based on area/volume solutions.

4. Calculate trigometric values.
   a. Calculate angle values of a triangle.
   b. Solve geometric construction based on angular solutions.

5. Calculate industry expenses.
   a. Prepare a cost analysis.
   b. Compute overhead expenses.

   a. Use a calculator.
   b. Solve basic algebraic equations and conversions from fraction to decimal and metric.

STANDARDS

National Center for Construction Education and Research Standards

ELT2.1 Alternating Current (Module 26201-11)
Course Name: Drafting for Electrical Technology

Course Abbreviation: ELT 1163

Classification: Career, Technical, and Associate Elective

Description: Preparation and interpretation of schematics and electrical drawing and electrical blueprints (3 sch: 1-hr lecture, 4-hr lab)

Prerequisite: Fundamentals of Electricity ELT 1192 or by permission of instructor

### Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>Number</th>
<th>Statement</th>
</tr>
</thead>
</table>
| 1.     | Demonstrate an understanding of drafting fundamentals utilizing both hand- and computer-aided drafting and how it relates to the electrical industry.  
|        | a. Explain the need for national drafting standards.  
|        | b. Explain the need for drawing quality and standard drawing sizes.  
|        | c. Explain the requirements for lettering and different line widths.  
|        | d. Discuss computer aided design (CAD).  |
| 2.     | Demonstrate an understanding of electrical symbols, components, and references used in schematic and logic diagrams.  
|        | a. Identify components by symbol.  
|        | b. Draw component and schematic symbols to drafting standards.  
|        | c. Correctly use component references and values.  
|        | d. Use symbols in schematic diagrams.  
|        | e. Interpret logic symbols.  
|        | f. Create formal drawings from an engineering sketch.  |
| 3.     | Demonstrate the ability to compose projections and electrical drawings and diagrams.  
|        | a. Define and identify a perspective drawing.  
|        | b. Define and create orthographic, isometric, and oblique drawings.  
|        | c. Apply rules of good dimensioning to mechanical drawing.  
|        | d. Create printed circuit board assembly drawings.  
|        | e. Create block, flow, and single line diagrams.  
|        | f. Create schematic and logic diagrams.  
|        | g. Create point-to-point and pictorial point-to-point diagrams.  
|        | h. Create cable assemblies and interconnection diagrams.  |
| 4.     | Demonstrate an understanding of electronics drafting using CAD.  
|        | a. Create electronic symbols to drafting standards.  
|        | b. Insert symbols into drawings.  
|        | c. Use CAD commands to create drawings and schematic diagrams.  |

### STANDARDS

National Center for Construction Education and Research Standards

ELT1.10 Basic Electrical Construction Drawings
Course Name: Fundamentals of Electricity

Course Abbreviation: ELT 1192-3

Classification: Career, Technical, and Associate Core

Description: Fundamental skills associated with all electrical courses. Safety, basic tools, special tools, equipment, and introduction to simple AC and DC circuits (2 sch: 1-hr lecture, 2-hr lab)

Prerequisite: None

### Competencies and Suggested Objectives

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
</table>
| 1. | Apply general safety procedures in the shop, lab, and industrial environment. **DOK1, ELT1.2**  
  | a. Apply proper safety techniques for all types of circuits and components.  
  | b. Demonstrate an understanding of and comply with relevant OSHA safety standards.  
  | c. Demonstrate the use of lockout and tagout electrical procedures. |
| 2. | Demonstrate use of electrical tools, equipment, and references. **DOK2, ELT1.7, ELT1.12**  
  | a. Identify and demonstrate proper use of basic tools. Identify and demonstrate proper use of basic equipment including meters, drills, threaders, conduit benders, and other equipment.  
  | b. Demonstrate the use of and reading of a rule, tape, and architectural scale.  
  | c. Locate and interpret information in the NEC relative to a specific job. |
| 3. | Solve problems using Ohm’s law. **DOK1, ELT1.3**  
  | a. List three formulae for Ohm’s law.  
  | b. Solve problems for an unknown voltage, amperage, resistance, and wattage. |

### STANDARDS

National Center for Construction Education and Research Standards

ELT1.2 Electrical Safety (Module 26102-11)  
ELT1.3 Introduction to Electrical Circuits (Module 26103.11)  
ELT1.7 Hand Bending (Module 26107.11)  
ELT1.12 Electrical Test Equipment (Module 26112-11)
Course Name: Electric Power

Course Abbreviation: ELT 1213

Classification: Career, Technical, and Associate Core

Description: Electrical motors and their installation. Instruction and practice in using the different types of motors, transformers, and alternators (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3) or by permission of instructor

Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>1. Discuss safety and environmental protection concerns associated with electrical power equipment.</th>
<th>DOK1, ELT3.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. List safety precautions associated with motors and transformers.</td>
<td></td>
</tr>
<tr>
<td>b. Explain the procedures for working with and disposing of hazardous materials.</td>
<td></td>
</tr>
<tr>
<td>2. Wire single-phase electrical components.</td>
<td>DOK2, ELT2.2, ELT3.7</td>
</tr>
<tr>
<td>a. Sketch and connect a single-phase transformer for high- and low-voltage applications.</td>
<td></td>
</tr>
<tr>
<td>b. Identify, sketch, and wire different types of single-phase motors.</td>
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</tr>
<tr>
<td>c. Explain and demonstrate the applications of an AC generator.</td>
<td></td>
</tr>
<tr>
<td>3. Wire three-phase electrical components.</td>
<td>DOK2, ELT2.2, ELT3.7</td>
</tr>
<tr>
<td>a. Sketch and connect a three-phase AC transformer to include delta and wye and three-wire and four-wire systems.</td>
<td></td>
</tr>
<tr>
<td>b. Identify, draw, and wire different types of three-phase motors to include low and high voltage requirements.</td>
<td></td>
</tr>
</tbody>
</table>

STANDARDS

National Center for Construction Education and Research Standards

ELT2.2 Motors: Theory and Application (Module 26202-11)
ELT3.7 Transformers (Module 26307-11)
Course Name: Motor Maintenance and Troubleshooting

Course Abbreviation: ELT 1223

Classification: Career, Technical, and Associate Elective

Description: Principles and practice of electrical motor repair. Includes topics on the disassembly/assembly and preventive maintenance of common electrical motors (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3) or by permission of instructor

Competencies and Suggested Objectives

1. Apply general safety and safety requirements for working with electric motors. \( \text{DOK 1, ELT 1.2} \)
   a. Apply principles of safety in the use and repair of electrical motors.
   b. Describe safety procedures to utilize during connecting, operating, and repairing of electrical motors.
   c. Practice lockout/tagout procedure.

2. Use instruments and tools in maintaining, troubleshooting, and operating electrical motors. \( \text{DOK 2, ELT 1.12} \)
   a. Identify, describe, and demonstrate the use of instruments and tools used to maintain, troubleshoot, and repair motors to include mega-ohm meters, volt-amp meters, and multimeters.
   b. Describe the procedures for the maintenance, testing, and/or repair of instruments and tools.

3. Troubleshoot and perform basic maintenance on electrical motors. \( \text{DOK 2, ELT 2.2} \)
   a. List and describe functions of the major parts and windings of single-phase motors.
   b. List and describe the functions of split-phase, capacitor start, capacitor start-capacitor run, and permanent split capacitor electric motors.
   c. Describe and list the functions of a shaded pole and repulsion/induction electric motors.
   d. List and describe functions of major parts and windings of three-phase motors to include squirrel cage induction, synchronous, and wound rotor motors.
   e. List and describe functions of the major parts and windings of DC motors to include series, shunt, and compound wound motors.
   f. Develop a preventive maintenance program for electric motors.

STANDARDS

National Center for Construction Education and Research Standards

ELT1.2 Electrical Safety (Module 26102-11)
ELT1.12 Electrical Test Equipment (Module 26112-11)
ELT2.2 Motors: Theory and Application (Module 26202-11)
Course Name: Branch Circuit and Service Entrance Calculations

Course Abbreviation: ELT 1253

Classification: Career, Technical, and Associate Core

Description: Calculating circuit sizes for all branch circuits and service entrances in residential installation (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Residential/Light Commercial Wiring (ELT 1113) or by permission of instructor

Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>Competency</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Explain size and color of equipment grounding conductors for all branch circuits. DOK2, ELT2.9, ELT3.1, ELT3.2</td>
</tr>
<tr>
<td></td>
<td>a. Explain the different colors of equipment grounding conductors for all branch circuits.</td>
</tr>
<tr>
<td></td>
<td>b. Explain the equipment grounding conductor sizes in relationship to the rating or setting of the automatic overcurrent device ahead of the equipment (per NEC).</td>
</tr>
<tr>
<td>2.</td>
<td>Determine the minimum number of general-purpose branch circuits needed in a residential structure. DOK2, ELT2.9, ELT3.1, ELT3.2</td>
</tr>
<tr>
<td></td>
<td>a. Calculate the usable square footage of a dwelling for general-purpose application.</td>
</tr>
<tr>
<td></td>
<td>b. Compute the minimum wattage by NEC standards for total watts for general-purpose lighting and appliance circuits.</td>
</tr>
<tr>
<td></td>
<td>c. Compute the minimum number of 15-A or 20-A general-purpose branch circuits.</td>
</tr>
<tr>
<td>3.</td>
<td>Calculate the branch circuit sizes for individual branch circuits for residential wiring. DOK2, ELT2.9, ELT3.1, ELT3.2</td>
</tr>
<tr>
<td></td>
<td>a. Calculate the branch circuit conductor size for motors according to NEC.</td>
</tr>
<tr>
<td></td>
<td>b. Calculate the branch circuit conductor size for air conditioning and refrigeration equipment according to NEC.</td>
</tr>
<tr>
<td></td>
<td>c. Calculate the branch circuit size for appliances according to NEC.</td>
</tr>
<tr>
<td></td>
<td>d. Calculate the branch circuit size for heat according to NEC.</td>
</tr>
<tr>
<td>4.</td>
<td>Calculate the minimum number of branch circuits of the small appliance and laundry types. DOK2, ELT2.9, ELT3.1, ELT3.2</td>
</tr>
<tr>
<td></td>
<td>a. Explain the circuit size and specified area use of the small appliance and laundry branch circuits.</td>
</tr>
<tr>
<td></td>
<td>b. Explain the exceptions permitted by the NEC as to circuit area usage of small appliance branch circuits.</td>
</tr>
<tr>
<td>5.</td>
<td>Explain and demonstrate the procedure for calculating the residential service entrance conductor size using the standard or optional method according to NEC. DOK2, ELT2.9, ELT3.1, ELT3.2</td>
</tr>
<tr>
<td></td>
<td>a. Calculate the wattage of the small appliance and laundry circuits as specified in NEC.</td>
</tr>
<tr>
<td></td>
<td>b. Calculate the wattage of general-purpose branch circuits as specified in NEC.</td>
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<tr>
<td></td>
<td>c. Calculate the wattage of all appliances that may be permanently connected or on a specific circuit.</td>
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<tr>
<td></td>
<td>d. Demonstrate the procedure for calculating the heat and air-conditioning load as specified in NEC.</td>
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<tr>
<td>Course Code</td>
<td>Course Title</td>
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<tr>
<td>-------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>ELT2.9</td>
<td>Grounding and Bonding (Module 26209-11)</td>
</tr>
<tr>
<td>ELT3.1</td>
<td>Load Calculations – Branch and Feeder Circuits</td>
</tr>
<tr>
<td>ELT3.2</td>
<td>Conductor Selection and Calculations</td>
</tr>
</tbody>
</table>
Course Name: Blueprint Reading/Planning in Residential Installation

Course Abbreviation: ELT 1263

Classification: Career, Technical, and Associate Core

Description: Architectural symbols and electric symbols needed to read blueprints. All elevations and various plans associated with electrical wiring will be studied. Blank blueprints will be provided, and a list of all appliances and their amperage will be supplied. The blanks will be filled with receptacles, switches, and lighting outlets as required by NEC. Circuit layouts for all switching will be demonstrated. All branch circuits will be plotted on the blueprint. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3) or by permission of instructor

Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>Competency</th>
<th>DOK, ELT1.10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Explain ANSI symbols used in blueprint reading.</td>
<td></td>
</tr>
<tr>
<td>a. List and explain symbols used for circuits.</td>
<td></td>
</tr>
<tr>
<td>b. List and explain symbols used for lights, switches, appliances, and special connectors.</td>
<td></td>
</tr>
<tr>
<td>2. Explain plans and elevations critical to blueprint reading.</td>
<td>DOK1, ELT1.10</td>
</tr>
<tr>
<td>a. List the various plans.</td>
<td></td>
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<tr>
<td>b. Name the principal elevations.</td>
<td></td>
</tr>
<tr>
<td>c. Draw a basic floor plan.</td>
<td></td>
</tr>
<tr>
<td>d. Draw the four principal elevations.</td>
<td></td>
</tr>
<tr>
<td>3. Determine service entrance locations and heights.</td>
<td>DOK1, ELT1.10</td>
</tr>
<tr>
<td>a. Determine proper heights to install wall bracket lights and weatherproof GFCI outlets.</td>
<td></td>
</tr>
<tr>
<td>b. Determine finished grade and exterior structure finish.</td>
<td></td>
</tr>
<tr>
<td>4. Locate vertical wall receptacles, switches, and lighting outlets.</td>
<td>DOK1, ELT1.10</td>
</tr>
<tr>
<td>a. Sketch the location of all receptacles.</td>
<td></td>
</tr>
<tr>
<td>b. Sketch the location of all lights and switches.</td>
<td></td>
</tr>
<tr>
<td>c. Sketch the location of all special outlets.</td>
<td></td>
</tr>
<tr>
<td>5. Prepare blueprints to meet NEC minimum requirements.</td>
<td>DOK1, ELT1.10</td>
</tr>
<tr>
<td>a. Locate all receptacles, switches, and lighting outlets in each room.</td>
<td></td>
</tr>
<tr>
<td>b. Determine the wiring circuits for all light switching.</td>
<td></td>
</tr>
<tr>
<td>c. Lay out all appliances, multi-wire, individual, and general-purpose branch circuits.</td>
<td></td>
</tr>
</tbody>
</table>

STANDARDS

National Center for Construction Education and Research Standards

ELT1.10 Basic Electrical Construction Drawings (Module 26110-11)
Course Name: Switching Circuits for Residential, Commercial, and Industrial Applications

Course Abbreviation: ELT 1273

Classification: Career, Technical, and Associate Elective

Description: Introduction to various methods by which single-pole, 3-way, and 4-way switches are used in residential, commercial, and industrial installations. Also includes installation and operation of residential/commercial automation systems (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3) or by permission of instructor

Competencies and Suggested Objectives

1. Demonstrate various switching circuits. DOK2, ELT1.6, ELT1.9, ELT1.11, ELT3.8,
   a. Explain the mechanical and electrical operation of various switches using the different wiring arrangements.
   b. Demonstrate the single-pole switching arrangements with two-wire when the lighting outlet and switch are fed.
   c. Demonstrate the various three-way and four-way switching circuits using two-wire or three-wire cable.
   d. Demonstrate objectives 1a-1c using a conduit raceway.

2. Demonstrate and explain low voltage remote control wiring in residential/commercial automation systems. DOK2, ELT1.6, ELT1.9, ELT1.11, ELT3.8
   a. Demonstrate and explain the procedure for installing the residential/commercial automation systems.
   b. Explain the procedure for programming the residential/commercial automation systems.

STANDARDS

National Center for Construction Education and Research Standards

- ELT1.6 Device Boxes (Module 26106.11)
- ELT1.9 Conductors and Cables (Module 26109-11)
- ELT1.11 Residential Electrical Services (Module 26111-11)
- ELT3.8 Commercial Electrical Services (Module 26308-11)
Course Name: Estimating the Cost of an Electrical Installation

Course Abbreviation: ELT 1283

Classification: Career, Technical, and Associate Elective

Description: Cost of an electrical installation. Specifications set forth for a particular structure (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3), Residential/Commercial Wiring (ELT 1113), or by permission of instructor

Competencies and Suggested Objectives

1. Calculate the total projected cost of materials and labor by using the results of a time and motion study, actual cost of materials, and margin of profit. DOK1, ELT1.6, ELT1.9
   a. Prepare a lighting fixture schedule for a structure by determining which circuits require specific lights for the individual rooms.
   b. Prepare a branch circuit material schedule.
   c. Prepare a labor unit schedule for an electrical installation.
   d. Prepare an estimate of materials used in an installation

2. Prepare a branch circuit schedule. DOK1, ELT1.6, ELT1.9
   a. Determine which rooms are on a particular branch circuit.
   b. Determine the number of lighting outlets that are on the particular branch circuit.
   c. Determine the number of switch outlets that are on a particular branch circuit.
   d. Determine the number of receptacle outlets that are on a particular branch circuit.

STANDARDS

National Center for Construction Education and Research Standards

ELT1.6 Device Boxes (Module 26106.11)
ELT1.9 Conductors and Cables (Module 26109-11)
Course Name: Automated Manufacturing Controls for Electrical Technology

Course Abbreviation: ELT 1313

Classification: Career, Technical, and Associate Elective

Description: This course is designed to teach the students the integrated control systems found in automated systems. Emphasis will be placed on encoders, optical devices, servo motors, stepper motors, computerized numerical control (CNC), vision and sensing systems, lasers, programmatic controllers, solid state motor controls, and other similar devices. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Motor Controls ELT1413, PLC’s ELT 2613, Solid State Motor Controls ELT 2424, or by permission of instructor

Competencies and Suggested Objectives

1. Demonstrate the ability to develop a robotics process utilized in the electrical industry. DOK2, ELT3.11, ELT4.7, ELT4.10
   a. Plan a process.
   b. Design and lay out a process using a programmable logic control.

2. Demonstrate the ability to interface components of a robotics process and how they relate to the electrical industry. DOK2, ELT3.11, ELT4.7, ELT4.10
   a. Integrate communication links between PLC, computer, and robot.
   b. Integrate and maintain interlock of sequential operations using PLC and control wiring.
   c. Utilize contact and noncontact sensors.
   d. Integrate peripheral equipment into the process.

3. Demonstrate the ability to evaluate and troubleshoot a robotics process. DOK2, ELT3.11, ELT4.7, ELT4.10
   a. Evaluate system performance.
   b. Apply problem-solving logic.
   c. Read and interpret schematics.
   d. Explain and operate basic test equipment.

STANDARDS

National Center for Construction Education and Research Standards

ELT3.11 Motor Controls (Module 26311-11)
ELT4.7 Advanced Controls (Module 26407-11)
ELT4.10 Motor Operation and Maintenance (Module 26410-11)
Course Name: Calibration and Measurement Principles Used in the Electrical Industry

Course Abbreviation: ELT 1324

Classification: Career, Technical, and Associate Elective

Description: This course introduces the students to various terms related to measurement principles and calibration techniques used in the electrical industry. With PLCs, the topic also includes the procedures and calibration of various instruments and PLCs used in industry. (4 sch: 3-hr lecture, 2-hr lab)

Prerequisite: Programmable Logic Controls ELT 2613 and Advanced Programmable Controls ELT 2623

Competencies and Suggested Objectives

1. Define terms associated with measurement and calibration procedures used in the electrical industry. DOK1, INS2.4, INS2.5, INS 2.6, INS2.7, INS2.12, INS2.13, INS2.14
   a. Describe traceability of a standard.
   b. Describe and explain static and dynamic characteristics of an instrument.
   c. Explain elevated and suppressed zero.
   d. Discuss instrument drift.
   e. Discuss units of measurement pertaining to instrumentation.

2. Describe a standard calibration procedure used in the electrical industry. DOK2, INS2.4, INS2.5, INS 2.6, INS2.7, INS2.12, INS2.13, INS2.14
   a. Develop a generic calibration procedure.
   b. Perform a calibration procedure on different instrumentation apparatus.
   c. Calibrate a PLC for installation.

3. Describe and demonstrate Statistical Process Control (SPC). DOK2, INS2.4, INS2.5, INS 2.6, INS2.7, INS2.12, INS2.13, INS2.14
   a. Perform basic operations of statistics.
   b. Explain statistics and the relationship to process control instrumentation.

STANDARDS

National Center for Construction Education and Research Standards

INS2.4 Process Control Theory (Module 12204-03)
INS2.5 Detectors, Secondary Elements, Transducers, and Transmitters (Module 12205-03)
INS2.6 Controllers, Recorders, and Indicators (Module 12206-03)
INS2.7 Control Valves, Actuators, and Positioners (Module 12207-03)
INS2.12 Panel-Mounted Instruments (Module 12212-03)
INS2.13 Installing Field-Mounted Instruments (Module 12213-03)
INS2.14 Raceways for Instrumentation (Module 12214-03)
Course Name: Flexible Manufacturing Systems for Electrical Technology

Course Abbreviation: ELT 1334

Classification: Career, Technical, and Associate Elective

Description: This course is a production project that requires the student to apply technical skills acquired in previous courses. Project management is provided by the instructor with the students working as teams in each particular area of the manufacturing system. The students are required to plan the project and prepare the integrated system to manufacture a product. This includes all software, hardware, fixtures, clamping mechanisms, material handling requirements, sensors and interfacing, and external control devices. (4 sch: 2-hr lecture, 4-hr lab)

Prerequisite: Motor Controller (ELT 1413), Advanced PLCs (ELT 2623), Solid State Motor Controls (ELT 2424), or by permission of instructor

Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>1.</th>
<th>Plan a project that will utilize the automated system used in the electrical industry. DOK3, ELT3.11, ELT4.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Develop documentation that outlines major steps in the program.</td>
</tr>
<tr>
<td>b.</td>
<td>Develop a process flowchart that identifies and sequences primary production steps.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2.</th>
<th>Plan and specify the automation equipment required for the electrical project. DOK2, ELT3.11, ELT4.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Identify the automation equipment required to support the project.</td>
</tr>
<tr>
<td>b.</td>
<td>Identify and list the individual process steps with supporting addresses and control data.</td>
</tr>
<tr>
<td>c.</td>
<td>Identify the material requirements.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3.</th>
<th>Develop and program the project. DOK3, ELT3.11, ELT4.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Develop the initialization programming logic.</td>
</tr>
<tr>
<td>b.</td>
<td>Develop the input/output logic.</td>
</tr>
<tr>
<td>c.</td>
<td>Develop the process control logic.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4.</th>
<th>Test and debug the project. DOK2, ELT3.11, ELT4.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Configure the automation system for the project.</td>
</tr>
<tr>
<td>b.</td>
<td>Troubleshoot and correct the program syntax and logic problems.</td>
</tr>
</tbody>
</table>

STANDARDS

National Center for Construction Education and Research Standards

| ELT3.11 | Motor Controls (Module 26311-11) |
| ELT4.7 | Advanced Controls (Module 26407-11) |
Course Name: Fundamentals of Instrumentation

Course Abbreviation: ELT 1343

Classification: Career, Technical, and Associate Elective

Description: This course provides students with a general knowledge of instrumentation principles as they relate to the electrical industry. This course includes instruction in the basis of hydraulics and pneumatics and the use of electrical circuits in the instrumentation process. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3), AC and DC Circuits (ELT 1144), or by permission of instructor

Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>1. Demonstrate a working knowledge of instrumentation as it pertains to the electrical industry. DOK2, INS1.1, INS1.3, INS1.4, INS1.7, INS1.10</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Define terms associated with instrumentation.</td>
</tr>
<tr>
<td>b. Discuss basic theory of hydraulics, pneumatics, and electromagnetic controls.</td>
</tr>
<tr>
<td>c. Identify basic symbols used with hydraulics, pneumatics, and electromagnetic systems.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Identify the type of instrumentation input and output devices, and describe their applications. DOK2, INS1.1, INS1.3, INS1.4, INS1.7, INS1.10</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Describe control elements for pressure, flow, temperature, and level.</td>
</tr>
<tr>
<td>b. Identify the types of input and output devices.</td>
</tr>
<tr>
<td>c. Describe the input and output devices.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. Identify the types of electrical signals used in instrumentation. DOK1, INS1.1, INS1.3, INS1.4, INS1.7, INS1.10</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Describe the transmission of information to include current, pressure, and frequency.</td>
</tr>
<tr>
<td>b. Explain the principles of the transmission information input and output.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. Describe fundamentals of electrical and electronic process controls. DOK1, INS1.1, INS1.3, INS1.4, INS1.7, INS1.10</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Label a block diagram of an open loop system and a closed loop system.</td>
</tr>
<tr>
<td>b. Describe characteristics of an open loop and a closed loop system.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. Design a preventive maintenance program for instrumentation systems. DOK2, INS1.1, INS1.3, INS1.4, INS1.7, INS1.10</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Describe the techniques and procedures for troubleshooting, calibrating, and repairing an instrumentation system.</td>
</tr>
<tr>
<td>b. Demonstrate the ability to sketch a piping and instrument drawing.</td>
</tr>
</tbody>
</table>
STANDARDS

National Center for Construction Education and Research Standards

INS1.1  Hand Tools for Instrumentation (Module 12101-01)
INS1.3  Power Tools for Instrumentation (Module 12103-01)
INS1.4  Electrical Systems for Instrumentation (Module 12104-01)
INS1.7  Instrumentation Drawings and Documents, Part One (Module 12107-01)
INS1.10 Flow, Pressure, Level, and Temperature (Module 12110-01)
Course Name: Fundamentals of Robotics for Electrical Technology

Course Abbreviation: ELT 1353

Classification: Career, Technical, and Associate Elective

Description: This course is designed to introduce the student to industrial robots. Topics to be covered include robotics history, industrial robot configurations, operation, and basic programming and how they relate to the electrical industry. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3), Motor Controls (ELT 1413), PLCs (ELT 2613), Solid State Motor Control (ELT 2424), and Automated Manufacturing Controls for Electrical Technology (ELT 1313).

Competencies and Suggested Objectives

1. Describe the various major components of all robots. DOK1, EST3.7, INS1.1, INS1.2, INS1.3
   a. Explain the axes of movement.
   b. Label each major component.
   c. Identify four general types of work envelopes.
   d. Discuss three general forms of robot actuation.
   e. Identify different types of input devices used with robot controllers.
   f. Describe the characteristics of a robot that distinguish it from other types of automated machinery.

2. Demonstrate safety procedures used in the automated environment. DOK1, EST3.7, INS1.1, INS1.2, INS1.3
   a. Apply safety rules for personal and general shop safety including eye, ear, and body protection; general rules of shop conduct; and the use of safety color coding.
   b. Apply general safety rules for tool and equipment use including hand tools, air and electric power tools, and other shop equipment.
   c. Apply general safety rules associated with working on various robotics systems.
   d. Apply rules and procedures associated with fire safety including procedures for handling and storing flammable liquids and proper use of firefighting devices.

3. Demonstrate the ability to operate robots. DOK1, EST3.7, INS1.1, INS1.2, INS1.3
   a. Evaluate robot performance.
   b. Apply basic programming skills.
   c. Identify and discuss end effectors.
   d. Identify and discuss visual and tactile sensors.
   e. Demonstrate basic troubleshooting techniques.

STANDARDS

National Center for Construction Education and Research Standards

EST3.7 Maintenance and Repair (Module 33307-11)
INS1.1 Hand Tools for Instrumentation (Module 12101-01)
INS1.2 Electrical Safety (Module 12102-01)
INS1.3 Power Tools for Instrumentation (Module 12103-01)
Course Name: Industrial Hydraulics for Electrical Technology

Course Abbreviation: ELT 1363

Classification: Career, Technical, and Associate Elective

Description: This course introduces the students to basic hydraulics, hydraulic actuators, accumulators, valves, pumps, motors, fluids, coolers, and filters. Emphasis is placed on development of hydraulic control circuits, electrical interfacing techniques, and troubleshooting. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3), Motor Controls (ELT 1413), PLCs (ELT 2613), or by permission of instructor

Competencies and Suggested Objectives

1. Define and describe basic laws governing liquids.
   a. Describe the concept of force, flow, and pressure.
   b. Analyze the relationship of force and pressure of a circuit.
   c. Explain what causes flow in a circuit.
   d. Calculate area, pressure, velocity, and rate of flow.
   e. Explain and apply Pascal’s law in hydraulics.

2. Identify and draw symbols for hydraulics used in the electrical industry.
   a. Explain the logic for drawing symbols for hydraulic components.
   b. Draw individual hydraulic components.

3. Describe operation and nomenclature of various pumps.
   a. Analyze the operation of vane, gear, and piston pumps.
   b. Describe the operation of centrifugal pumps.

4. Explain liquids as pertaining to the transmission of energy.
   a. Describe various types of hydraulic fluid.
   b. Explain the purpose of the fluid reservoir, filtration system, and the heat exchange in hydraulics.
   c. Illustrate the relationship of viscosity, temperature, and resistance.

5. Describe the operation of flow, pressure, and directional control valves.
   a. Explain basic design features used in each type of control valve.
   b. Demonstrate how flow, pressure, and directional valves are used.

6. Explain the types of actuators used in hydraulics.
   a. List important cylinder design features.
   b. Explain basic design features of hydraulic motors and other rotary actuators.

7. Explain, construct, and troubleshoot various hydraulic applications in the electrical industry.
   a. Explain the purpose of a sequence circuit.
   b. Construct and troubleshoot a sequence circuit.
   c. Explain the purpose of a counterbalance circuit.
   d. Construct and troubleshoot a counterbalance circuit.
8. Interface electrical and hydraulic circuits, DOK2, IMM3.11
   a. Wire an electrical control circuit.
   b. Interface a hydraulic circuit with ladder logic.
   c. Interface a hydraulic circuit with PLCs.

STANDARDS

*National Center for Construction Education and Research Standards*

IMM3.11 Hydraulic Controls (Module 40311-09)
Course Name: Industrial Pneumatics for Electrical Technology

Course Abbreviation: ELT 1373

Classification: Career, Technical, and Associate Elective

Description: This course introduces the students to basic pneumatic principles, compression of air, work devices, control devices, and circuit diagrams. Emphasis is placed on development of pneumatic control circuits, electromechanical control of fluid power, and troubleshooting techniques. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3), Motor Controls (ELT 1413), PLCs (ELT 2613), or by permission of instructor

Competencies and Suggested Objectives

1. Define and describe basic laws governing gases. DOK2, IMM3.12
   a. Describe the concept of force, flow, and pressure.
   b. Analyze the relationship of force and pressure on a circuit.
   c. Explain what causes flow in a circuit.
   d. Calculate area, pressure, velocity, and rate of flow.
   e. Explain and apply Charles’ law in pneumatics.
   f. Explain and verify Boyle’s law in a circuit.

2. Identify and draw symbols for pneumatics used in the electrical industry. DOK1, IMM3.12
   a. Explain the logic for drawing symbols for pneumatic components.
   b. Draw individual pneumatic components.

3. Describe the operation and nomenclature of various compressors. DOK2, IMM3.12
   a. Analyze the operation of vane and piston pumps in pneumatics.
   b. Analyze the operation of air compressors.

4. Explain fluids as pertaining to the transmission of energy. DOK2, IMM3.12
   a. Explain the purpose of the receiver tanks, filtration system, and heat exchanger.
   b. Describe the purpose of pressure drops in pneumatic systems.

5. Describe the operation of flow, pressure, and directional control valves. DOK2, IMM3.12
   a. Explain basic design features used in each type of control valve.
   b. Demonstrate how flow, pressure, and directional valves are used in pneumatics.

6. Explain the types of actuators used in pneumatic applications in the electrical technology. DOK1, IMM3.12
   a. List important cylinder design features.
   b. Explain basic design features of rotary actuators.
   c. Identify common types of air motors.

7. Explain, construct, and troubleshoot various pneumatic circuits utilizing pneumatic, electrical, and electronic controls. DOK2, IMM3.12
   a. Explain the purpose of a sequence circuit.
   b. Construct and troubleshoot a sequence circuit.

8. Demonstrate the use of electromechanical controls in hydraulic and pneumatic circuits. DOK2, IMM3.12
   a. Explain the construction and use of solenoids in directional controls.
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>b.</td>
<td>Construct a pneumatic circuit that is controlled electrically.</td>
</tr>
</tbody>
</table>

**STANDARDS**

*National Center for Construction Education and Research Standards*

IMM3.12  Pneumatic Controls (Module 40312-09)
Course Name: Industrial Robotics for Electrical Technology

Course Abbreviation: ELT 1383

Classification: Career, Technical, and Associate Elective

Description: This course teaches the operating systems and advanced programming methods of industrial robots. Actual industrial-grade robots are used to train the student in the areas of operation, maintenance, troubleshooting, service procedures, and robotics applications. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Robotics (ELT 1353).

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Demonstrate the ability to integrate a robot into a process affiliated with the electrical industry. DOK2, EST3.7</td>
</tr>
<tr>
<td>a. Write programs on industrial robots to perform simulated industrial processes to operate within the confines of each robot’s work envelope.</td>
</tr>
<tr>
<td>b. Demonstrate the improvement of the efficiency of an automated robotics process by reducing cycle time, decreasing memory usage, using advanced programming techniques, and so forth.</td>
</tr>
<tr>
<td>2. Demonstrate the ability to integrate peripheral equipment. DOK2, EST3.7</td>
</tr>
<tr>
<td>a. Program and interface peripheral devices such as a programmable logic controller into robotics work cells.</td>
</tr>
<tr>
<td>b. Interface contact and noncontact sensors into robotics work cell.</td>
</tr>
<tr>
<td>3. Demonstrate the ability to troubleshoot and maintain a robotics work cell. DOK2, EST3.7</td>
</tr>
<tr>
<td>a. Locate and isolate faults in robotics applications.</td>
</tr>
<tr>
<td>b. Demonstrate the use of test equipment and troubleshooting logic to repair faults.</td>
</tr>
<tr>
<td>c. Perform routine maintenance procedures on robots with the use of checklists and service equipment (null servo valves, zero encoders, calibrate potentiometers, etc.).</td>
</tr>
</tbody>
</table>

STANDARDS

National Center for Construction Education and Research Standards

EST3.7 Maintenance and Repair (Module 33307-11)
Course Name: Servo Control Systems for Electrical Technology

Course Abbreviation: ELT 1393

Classification: Career, Technical, and Associate Elective

Description: This course is designed to teach servo components; servo valves; velocity servos; positional servos; force, pressure, and torque servos; servo amplifiers; programmers; and servo analysis. Emphasis is placed on servo trim and maintenance and the applications of servo systems. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: None

Competencies and Suggested Objectives

1. Identify and discuss the components and characteristics of a servo system used in the electrical industry. DOK2, ELT4.7
   a. Identify the components of a basic electrohydraulic servo system.
   b. Identify servo valves as to control type and construction.
   c. Demonstrate operating characteristics of a servo valve by conducting performance tests.
   d. Explain servo valve construction, operation, and function.
   e. Identify the types of pilot stages for servo valves.
   f. Mechanically and/or electrically null a servo valve.
   g. Test a servo valve for flow gain, saturation, and linearity.
   h. Test a servo valve for pressure gain.

2. Demonstrate the ability to construct and analyze open loop and closed loop systems. DOK2, ELT4.7
   a. Draw a block diagram of a closed loop servo system.
   b. Identify and explain five control modes of a closed loop servo system.
   c. List and describe transducers commonly used with angular, linear, and velocity control systems.
   d. Construct and analyze open loop and closed loop velocity control systems.
   e. Construct and analyze open loop and closed loop angular position control systems.
   f. Construct and analyze open loop and closed loop linear position control systems.
   g. Demonstrate the concepts of accuracy, error, gain, response, and stability of closed loop servo systems.

3. Demonstrate the ability to troubleshoot and repair a servo control system used in the electrical industry. DOK2, ELT4.7
   a. Apply troubleshooting logic to solve electrical problems with a servo control system.
   b. Apply troubleshooting logic to locate and repair a fault in the hydraulic section of an electrohydraulic servo control system.
   c. Construct and demonstrate an angular position control system as it relates to a simulated machine function.
   d. Construct and demonstrate velocity control as it relates to a simulated machine function.
   e. Construct and demonstrate linear position control as it relates to a simulated machine function.
function.

STANDARDS

National Center for Construction Education and Research Standards

ELT4.7 Advanced Controls (Module 26407-11)
Course Name: Motor Control Systems

Course Abbreviation: ELT 1413

Classification: Career, Technical, and Associate Core

Description: Installation of different motor control circuits and devices. Emphasis is placed on developing the student’s ability to diagram, wire, and troubleshoot the different circuits and mechanical control devices. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3) or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Install different control circuits and devices.</td>
</tr>
<tr>
<td>a. Diagram and wire a two-wire and three-wire motor control circuit with indicating pilot lights.</td>
</tr>
<tr>
<td>b. Diagram, wire, and troubleshoot an on-delay and off-delay timer circuit.</td>
</tr>
<tr>
<td>c. Diagram and wire multi-control manual station.</td>
</tr>
<tr>
<td>d. Diagram and wire a “hands-off-automatic” control station.</td>
</tr>
<tr>
<td>e. Diagram and wire a jog-forward/jog-reverse control.</td>
</tr>
<tr>
<td>2. Troubleshoot different control circuits and devices.</td>
</tr>
<tr>
<td>a. Troubleshoot a two-wire and three-wire motor control circuit with indicating pilot lights.</td>
</tr>
<tr>
<td>b. Troubleshoot an on-delay and off-delay timer circuit.</td>
</tr>
<tr>
<td>c. Troubleshoot a multi-control manual station.</td>
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<tr>
<td>d. Troubleshoot a “hands-off-automatic” control station.</td>
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<tr>
<td>e. Troubleshoot a jog-forward/jog-reverse control.</td>
</tr>
</tbody>
</table>

STANDARDS

National Center for Construction Education and Research Standards

ELT3.9 Motor Calculations (Module 26309-11)
ELT3.11 Motor Controls (Module 26311-11)
**Course Name:** Solid State Devices and Circuits for Electrical Technology

**Course Abbreviation:** ELT 1434

**Classification:** Career, Technical, and Associate Elective

**Description:** Active devices that include PN junction diodes, bipolar transistors, bipolar transistor circuits, and unipolar devices with emphasis on low-frequency application and troubleshooting. (4 sch: 2-hr lecture, 4-hr lab)

**Prerequisite:** Fundamentals of Electricity (ELT 1192-3) and AC/DC Circuits (ELT 1144) or by permission of instructor

### Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1.     | Explain the characteristics of semiconductor materials and theory of operation of PN junctions. **DOK1, ELT4.7**  
  a. Explain basic atomic structure.  
  b. Define intrinsic, P-type, and N-type.  
  c. Analyze an unbiased PN junction.  
  d. Analyze a forward biased PN junction.  
  e. Analyze a reverse biased PN junction. |
| 2.     | Explain semiconductor diode theory, and apply to diode circuits. **DOK2, ELT4.7**  
  a. Describe the characteristics of a diode.  
  b. Analyze and demonstrate half wave rectifier circuit.  
  c. Analyze and demonstrate full wave rectifier circuit.  
  d. Analyze and demonstrate bridge rectifier circuit. |
| 3.     | Analyze the operation of semiconductor special purpose diodes. **DOK2, ELT4.7**  
  a. Analyze and demonstrate the operation of zener diode circuit.  
  b. Analyze and demonstrate the operation of light emitting diode circuit.  
  c. Explain the characteristics of Schottkey diodes.  
  d. Explain the characteristics of varactor diodes. |
| 4.     | Analyze the operation of bipolar junction transistors. **DOK1, ELT4.7**  
  a. Define and identify transistor voltages and currents.  
  b. Analyze and demonstrate the operation of a DC common emitter circuit.  
  c. Demonstrate the use of collector curves.  
  d. Demonstrate the use of load lines.  
  e. Explain and demonstrate base, emitter, and voltage divider biasing. |
| 5.     | Explain and analyze the construction of BJT amplifiers. **DOK2, ELT4.7**  
  a. Analyze and discuss the basic operation of a common emitter voltage amplifier.  
  b. Given a common emitter amplifier circuit, draw the AC equivalent circuit, and solve for V-in, V-out, and A.  
  c. Explain how the swamped common emitter amplifier works, and discuss its advantages.  
  d. Given a swamped common emitter amplifier circuit, draw the AC equivalent circuit, and solve for Z-in, V-in, V-out, A.  
  e. Construct common emitter amplifier, and compare measured parameters to calculated |
values.
f. Given a cascaded common emitter amplifier, calculate gain of stage one, gain of stage
two, and output voltage.
g. Given a power amplifier circuit, solve for the maximum generator voltage that will
produce an unclipped output signal, and solve the maximum efficiency of the
amplifier.
h. Given an emitter-follower circuit, solve for Z-in, V-in, A, and V-out.
i. Describe the characteristics of a class A power amplifier to include the factors that
limit the power rating of a transistor.
j. Construct class A and class B amplifiers and troubleshoot the circuits.

6. Analyze the operation of field effect transistors, and demonstrate their applications. DOK2,
ELT4.7
a. Describe the basic construction of a JFET.
b. Calculate the proportional pinch off voltage, and determine the operating area of a
JFET.
c. Given a JFET circuit, and determine ID and Vds.
d. Given a JFET amplifier circuit, draw the AC equivalent circuit and solve for gmo, gm,
Z-in, V-in, A, and V-out.
e. Given a JFET source follower circuit with a given gm, solve for V-in, A, and V-out.
f. Illustrate the construction of and describe the operation of the depletion-mode and the
enhancement-mode MOSFET.
g. Analyze other FET applications such as multiplying, switching, chopper, AGC, and
sample and hold amplifier.

7. Analyze the operation of thyristors, and demonstrate their applications. DOK2, ELT4.7
a. Describe the four-layer diode, and discuss how it is turned on and off.
b. Describe how the SCR operates in different applications.
c. Construct a latching SCR with a varying input voltage, and determine when the output
voltage is latched.
d. Describe the main characteristics of the variations of the SCR, and discuss the
difference in device symbols.
e. Describe the characteristics of the diac and triac.
f. Calculate the intrinsic standoff voltage for a unijunction transistor (UJT), and state how
it works.
g. Analyze thyristor applications such as over voltage detector, sawtooth generator, SCR
crowbar, and controlled SCR circuits phase angle controlled circuits.
h. Construct thyristor circuits, and vary the latching parameters; measure the output to
view switching and control of the device.

STANDARDS

National Center for Construction Education and Research Standards

ELT4.7 Advanced Controls (Module 26407-11)
Course Name: Data Acquisition and Communications

Course Abbreviation: ELT 1513

Classification: Career, Technical, and Associate Elective

Description: This is a course in acquisition and communication of systems data in industrial automated applications. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: By permission of instructor

Competencies and Suggested Objectives

1. Explain data communication components used in automatic systems.
   - a. Identify characteristics and uses of various EIA standard data communication interfaces.
   - b. Describe standard serial communications used in computers.
   - c. Describe parallel communication interfaces.
   - d. Explain Ethernet.
   - e. Explain Controlnet.
   - f. CAN based networks.

2. Use data communication software PLC and a computer to connect a network.
   - a. Configure a computer for serial or parallel communications.
   - b. Perform data transfers between computers.
   - c. Use communication test equipment to troubleshoot communications links.

3. Use computers and/or controllers for data acquisition.
   - a. Interface sensors with computer or controller for data acquisition using Ethernet.
   - b. Configure software and computer for data acquisition from a PLC.

STANDARDS

National Center for Construction Education and Research Standards

ELT3.10 Voice, Data, and Video (Module 26310-11)
ELT3.11 Motor Controls (Module 26311-11)
ELT4.7 Advanced Controls (Module 26407-11)
Course Name: Fundamentals of Fiber Optics for Electrical Technology

Course Abbreviation: ELT 1523

Classification: Career, Technical, and Associate Elective

Description: Fiber-optic cable in modern industry applications (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3) and AC/DC Circuits (ELT 1144) or by permission of instructor

Competencies and Suggested Objectives

1. Demonstrate and practice general safety procedures in the school and work site environments. DOK2, ELT3.10, EST1.8, EST2.7, EST2.8, EST2.9, EST3.2
   a. Apply relevant and appropriate safety techniques.
   b. Demonstrate an understanding of and comply with relevant OSHA safety standards.

2. Describe the history and advantages of fiber-optic systems and how they relate to the electrical industry. DOK1, ELT3.10, EST1.8, EST2.7, EST2.8, EST2.9, EST3.2
   a. Describe the limitations of wire communications systems.
   b. List the advantages of optical fiber communications over electrical wire communications.

3. Explain the operation and application of optical signal sources. DOK1, ELT3.10, EST1.8, EST2.7, EST2.8, EST2.9, EST3.2
   a. Apply appropriate safety practices to optical signal sources.
   b. Explain the advantages and disadvantages of LEDs as optical signal sources.
   c. Explain the operation of modulator circuits for optical signal sources.

4. Explain the operation and application of fiber-optic system components. DOK1, ELT3.10, EST1.8, EST2.7, EST2.8, EST2.9, EST3.2
   a. Describe the construction of optical fibers.
   b. Explain optical fiber cable specifications.

5. Describe properties of different types of optical fibers. DOK2, ELT3.10, EST1.8, EST2.7, EST2.8, EST2.9, EST3.2
   a. Differentiate between the properties and characteristics of plastic and glass optical fibers.
   b. Describe the effect of core size on efficiency and bandwidth.
   c. Describe fiber-optic cables available for indoor and outdoor installation.
   d. Prepare and complete a splice of fiber-optic cable following industry standards and safety procedures.
   e. Describe requirements for certification as a fiber-optic technician.

6. Explain the installation, connection, terminations, and maintenance of a fiber-optic system in residential and commercial applications. DOK2, ELT3.10, EST1.8, EST2.7, EST2.8, EST2.9, EST3.2
   a. Show the proper installation of fiber-optic systems.
   b. Demonstrate the proper connections of fiber-optic systems.
   c. Demonstrate the proper terminations of fiber-optic systems.
   d. Show the proper maintenance of fiber-optic systems.

7. Demonstrate an understanding of how fiber optics are covered by the NEC. DOK2, ELT3.10, EST1.8, EST2.7, EST2.8, EST2.9, EST3.2
a. Explain protection of fiber-optic installation and terminations.
b. Demonstrate proper installations of raceways and wiring methods for fiber-optic applications.

8. Demonstrate the proper methods for termination of fiber optics.  
   a. List NEC references to fiber-optic installations.
   b. Demonstrate proper termination methods on various fiber-optic cables.

STANDARDS

National Center for Construction Education and Research Standards

ELT3.10 Voice, Data, and Video (Module 26310-11)
EST1.8 Low-Voltage Cabling (Module 33108-10)
EST2.7 Introduction to Codes and Standards (Module 33207-10)
EST2.8 Cable Selection (Module 33208-10)
EST2.9 Wire and Cable Terminations (Module 33209-10)
EST3.2 Fiber Optics (Module 33302-11)
Course Name: Fundamentals of Data Communications for Electrical Technology

Course Abbreviation: ELT 1533

Classification: Career, Technical, and Associate Elective

Description: Concepts of telephony, local area networks, wide area networks, data transmission, and topology methods. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: none

### Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>1. Discuss basic communications and how they relate to the electrical industry in modern manufacturing plants.</th>
<th>DOK2, ELT3.10, ELT4.5, EST2.8, EST2.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Analyze various communication procedures between a computer and PLC.</td>
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<tr>
<td>b. Explain the differences between analog and digital communication using a PLC.</td>
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</table>

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<thead>
<tr>
<th>2. Analyze hardware, media, and software for use in data communication used between PLCs and computers in manufacturing plants.</th>
<th>DOK1, ELT3.10, ELT4.5, EST2.8, EST2.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Discuss uses of modems.</td>
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<tr>
<td>b. Describe various communications media.</td>
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<tr>
<td>c. Describe data transmission codes and protocols.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>3. Discuss communication networks and the installation of each.</th>
<th>DOK2, ELT3.10, ELT4.5, EST2.8, EST2.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Discuss industrial network basics (Ethernet, Controlnet, CAN, and Devicenet).</td>
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<tr>
<td>b. Analyze local area networks.</td>
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<tr>
<td>c. Analyze wide area networks.</td>
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<tr>
<td>d. Discuss planning, design, and implementation of networks.</td>
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</table>

<table>
<thead>
<tr>
<th>4. Discuss the future of communication and the electrical industry within manufacturing plants.</th>
<th>DOK2, ELT3.10, ELT4.5, EST2.8, EST2.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Analyze current trends and issues.</td>
<td></td>
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<tr>
<td>b. Utilize teleconferencing/video conferencing techniques.</td>
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</tbody>
</table>

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<thead>
<tr>
<th>5. Demonstrate the use of the Internet.</th>
<th>DOK1, ELT3.10, ELT4.5, EST2.8, EST2.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Explain what the Internet is.</td>
<td></td>
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<tr>
<td>b. Use electronic mail on the Internet.</td>
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<tr>
<td>d. Utilize browsers to scan the Internet.</td>
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</tbody>
</table>

### STANDARDS

*National Center for Construction Education and Research Standards*

ELT3.10 Voice, Data, and Video (Module 26310-11)
ELT4.5 Fire Alarm Systems (Module 26405-11)
EST2.8 Cable Selection (Module 33208-10)
EST2.9 Wire and Cable Terminations (Module 33209-10)
Course Name: Network Systems for Electrical Technology

Course Abbreviation: ELT 1544

Classification: Career, Technical, and Associate Elective

Description: Networking fundamentals, voice networking, LANs, and Internet. Also, upgrading of computers to support LAN technology (4 sch: 2-hr lecture, 4-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3) and AC/DC Circuit (ELT 1144) or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
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</thead>
<tbody>
<tr>
<td>1. Demonstrate and practice general safety procedures in the school and work site environments. <strong>DOK1, ELT3.11, ELT4.7, EST3.5</strong></td>
</tr>
<tr>
<td>a. Apply relevant and appropriate safety techniques.</td>
</tr>
<tr>
<td>b. Demonstrate an understanding of and comply with relevant OSHA safety standards.</td>
</tr>
<tr>
<td>2. Discuss, describe, apply network fundamentals, and install network software used in the industrial manufacturing plants. <strong>DOK2, ELT3.11, ELT4.7, EST3.5</strong></td>
</tr>
<tr>
<td>a. Discuss the history of telecommunication’s networking.</td>
</tr>
<tr>
<td>b. Discuss the handling and routing of calls.</td>
</tr>
<tr>
<td>c. Discuss and/or define standards and terminology.</td>
</tr>
<tr>
<td>d. Discuss network architectures and OSI.</td>
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<tr>
<td>e. Discuss, define, and relate analog and digital signals to networking.</td>
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<tr>
<td>f. Discuss, describe, and relate transmission media to networking.</td>
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<tr>
<td>g. Prepare both network hardware and software for computer installation to PLC operation.</td>
</tr>
<tr>
<td>h. Identify proper card slots for hardware installation.</td>
</tr>
<tr>
<td>3. Discuss internetworking devices. <strong>DOK2, ELT3.11, ELT4.7, EST3.5</strong></td>
</tr>
<tr>
<td>a. Explain multiplexers.</td>
</tr>
<tr>
<td>b. Identify the uses of repeaters.</td>
</tr>
<tr>
<td>c. Examine the uses of PLC bridges and gateways.</td>
</tr>
<tr>
<td>d. Analyze the uses of hubs and switches.</td>
</tr>
<tr>
<td>e. Discuss wireless networking equipment.</td>
</tr>
<tr>
<td>4. Discuss and describe voice networks, and troubleshoot network communications interface. <strong>DOK1, ELT3.11, ELT4.7, EST3.5</strong></td>
</tr>
<tr>
<td>a. Discuss the public and private switching telephone network.</td>
</tr>
<tr>
<td>b. Discuss and describe voice processing and call distribution.</td>
</tr>
<tr>
<td>c. Discuss and describe T1 networks.</td>
</tr>
<tr>
<td>d. Discuss and describe virtual networks.</td>
</tr>
<tr>
<td>5. Discuss, install, and troubleshoot LANs. <strong>DOK2, ELT3.11, ELT4.7, EST3.5</strong></td>
</tr>
<tr>
<td>a. Discuss and describe LANs.</td>
</tr>
<tr>
<td>b. Discuss network software.</td>
</tr>
<tr>
<td>c. Install LAN system, and verify for operation.</td>
</tr>
<tr>
<td>d. Discuss and define network protocols.</td>
</tr>
<tr>
<td>6. Access the Internet. <strong>DOK1, ELT3.11, ELT4.7, EST3.5</strong></td>
</tr>
</tbody>
</table>
a. Discuss and interconnect with LANs.

STANDARDS

National Center for Construction Education and Research Standards

ELT3.11 Motor Controls (Module 26311-11)
ELT4.7 Advanced Controls (Module 26407-11)
EST3.5 Rack Assembly (Module 33305-11)
Course Name: Satellite Systems

Course Abbreviation: ELT 1553

Classification: Career, Technical, and Associate Elective

Description: Service, repair, and installation of residential and commercial satellite receiving systems and how they are used in the electrical industry (3 sch: 1-hr lecture, 4-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3) and AC/DC Circuits (ELT 1144) or by permission of instructor

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>1. Demonstrate and practice general safety procedures in the school and work site environments. DOK1, ELT3.10, EST4.5, EST4.6</td>
</tr>
<tr>
<td>a. Apply relevant and appropriate safety techniques.</td>
</tr>
<tr>
<td>b. Demonstrate an understanding of and comply with relevant OSHA safety standards.</td>
</tr>
<tr>
<td>2. Identify and describe the basic principles and types of satellite systems. DOK1, ELT3.10, EST4.5, EST4.6</td>
</tr>
<tr>
<td>a. Describe the basic principles of satellite reception.</td>
</tr>
<tr>
<td>b. Identify the types of satellite systems, and describe their differences and functions.</td>
</tr>
<tr>
<td>3. Install, align, and service satellite systems in commercial and residential locations. DOK2, ELT3.10, EST4.5, EST4.6</td>
</tr>
<tr>
<td>a. Determine best location, install, and align a satellite receiver for correct tracking.</td>
</tr>
<tr>
<td>b. Troubleshoot and repair faulty components in a satellite receiver system.</td>
</tr>
<tr>
<td>4. Identify specific NEC references for the use of satellite systems. DOK1, ELT3.10, EST4.5, EST4.6</td>
</tr>
<tr>
<td>a. Look at the installation requirements for a satellite system.</td>
</tr>
<tr>
<td>b. Develop a detailed material list, and estimate for the installation of specific satellite systems.</td>
</tr>
</tbody>
</table>

STANDARDS

National Center for Construction Education and Research Standards

ELT3.10 Voice, Data, and Video (Module 26310-11)
EST4.5 CCTV Systems (Module 33405-03)
EST4.6 Broadband Systems (Module 33406-03)
Course Name: Telephone Systems for Special Systems Electrical Technology

Course Abbreviation: ELT 1564

Classification: Career, Technical, and Associate Elective

Description: Information and hands-on experience in installation, operation, troubleshooting, and repair of residential- and commercial-use telephone systems, including analog and digital key systems (4 sch: 3-hr lecture, 2-hr lab)

Prerequisite: None

Competencies and Suggested Objectives

1. Demonstrate and practice general safety procedures in the school and work site environments.  DOK1, ELT3.10, ELT4.5, EST4.6, EST4.11
   a. Apply relevant and appropriate safety techniques.
   b. Demonstrate an understanding of and comply with relevant OSHA safety standards.

2. Explain and analyze the aspects of basic telephone service.  DOK2, ELT3.10, ELT4.5, ELT4.7, EST4.6, EST4.11
   a. Explain the principal parts of the telephone and the function of each.
   b. Analyze the characteristics of analog and digital signals.
   c. Explain the nationwide and worldwide numbering systems.
   d. Differentiate between landline and wireless telephone systems.
   e. Troubleshoot systems and their applications.

3. Explain and test the operation and installation of key systems.  DOK2, ELT3.10, ELT4.5, ELT4.7, EST4.6, EST4.11
   a. Describe the key system advantages and components, and their functions, voltages, and operation.
   b. Develop an installation plan to include results of the site survey, floor plans, set locations, equipment locations, list of materials, and costs.
   c. Identify, interpret, and develop a blueprint using symbols for telephone system installation.
   d. Install a key security system using the proper tools following manufacturer’s specifications, proper grounding procedures, and all applicable safety practices.
   e. Identify malfunctions in the key security system using approved troubleshooting procedures, and make repairs as necessary.

4. Explain and test the operation and installation of digital key systems.  DOK2, ELT3.10, ELT4.5, ELT4.7, EST4.6, EST4.11
   a. Identify and describe the advantages and components and their functions, voltages, and operation.
   b. Describe the uses and limitations of block diagrams as they relate to installation.
   c. Explain and define the use and interconnection of data communications systems with a digital key system to include fiber interface, ISDN, and T-1s.
   d. Explain and outline network protocol as it pertains to the digital key system interaction with data communications networks.
   e. Develop an installation plan to include results of the site survey, floor plans, set locations, equipment locations, list of materials, and costs.
f. Install a key system using the proper tools following manufacturer’s specifications, proper grounding procedures, and all applicable safety practices.
g. Identify malfunctions in the digital key system using approved troubleshooting procedures, and make necessary repairs.

5. Install a telephone system as per applicable codes.
   a. Explain the relevant NEC and other codes used in telephone systems.
   b. Design, install, and maintain raceways systems for telephone systems.

6. Demonstrate the ability to properly terminate a telephone system.
   a. Use the system proper system tools to terminate telephone systems.
   b. Follow proper codes and standards while terming a telephone system.

7. Install various special electrical systems used in the construction process, and follow all applicable codes and standards.
   a. Install a nurse call system.
   b. Install a fire alarm system.
   c. Install a security system.

STANDARDS

National Center for Construction Education and Research Standards

ELT3.10 Voice, Data, and Video (Module 26310-11)
ELT4.5 Fire Alarm Systems (Module 26405-11)
ELT4.7 Advanced Controls (Module 26407-11)
EST4.6 Broadband Systems (Module 33406-03)
EST4.11 Telecommunications Systems (Module 33411-05)
Course Name: Principles of Hydraulics and Pneumatics

Course Abbreviation: ELT 1614

Classification: Career Elective (Certificate); Technical and Associate Core (Degree)

Description: Instruction in basic principles of hydraulics and pneumatics and the inspection, maintenance, and repair of hydraulic and pneumatic systems (4 sch: 1 hr lecture, 6 hr lab) [May be taught as a 90-contact-hour lab in open-entry/open-exit career programs]

Prerequisite: None

Competencies and Suggested Objectives

1. Describe and discuss basic principles of hydraulics as related to industrial maintenance. DOK1, IMM3.11
   a. Identify the basic components of a hydraulic system, including fluids, filters, pumps, lines, control valves, cylinders, motors, and so forth.
   b. Interpret schematics of hydraulic systems.
   c. Differentiate between open and closed hydraulic systems.
   d. Practice safety precautions and procedures associated with hydraulic systems.

2. Inspect, maintain, and repair hydraulic systems. DOK2, IMM3.11
   a. Evaluate hydraulic pumps for pressure and flow.
   b. Inspect hydraulic valves for leakage and proper actions.
   c. Inspect hydraulic cylinders for leakage and proper operations.

3. Describe and discuss basic principles of pneumatics as associated with industrial maintenance. DOK1, IMM3.12
   a. Identify the components of a pneumatic system, including compressor, lines, control valves, gauges, filters, attachments, cylinders, and motors.
   b. Interpret schematics of pneumatic systems.
   c. Practice safety precautions and procedures associated with pneumatic systems.

4. Inspect, maintain, and repair pneumatic systems. DOK1, IMM3.12
   a. Perform scheduled preventive maintenance on an air compressor.
   b. Evaluate pneumatic equipment and devices for leakage and proper operation.

STANDARDS

National Center for Construction Education and Research Standards

IMM3.11 Hydraulic Controls (Module 40311-09)
IMM3.12 Pneumatic Controls (Module 40312-09)
**Course Name:** Equipment Maintenance, Troubleshooting, and Repair

**Course Abbreviation:** ELT 2114

**Classification:** Career Elective (Certificate); Technical and Associate Core (Degree)

**Description:** Maintenance and troubleshooting techniques, use of technical manuals and test equipment, and inspection/evaluation/repair of equipment (4 sch: 1hr lecture, 6hr lab)

**Prerequisite:** None

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### Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>Competency</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Discuss and apply proper safety procedures regarding maintenance, troubleshooting, and repair of equipment.</td>
</tr>
<tr>
<td>2.</td>
<td>Perform preventive maintenance on equipment.</td>
</tr>
<tr>
<td></td>
<td>a. Develop a preventive maintenance program for a given piece of equipment.</td>
</tr>
<tr>
<td></td>
<td>b. Inspect and adjust belts, chains, and other moving parts.</td>
</tr>
<tr>
<td></td>
<td>c. Lubricate a machine following manufacturer’s recommendations.</td>
</tr>
<tr>
<td>3.</td>
<td>Troubleshoot and repair equipment.</td>
</tr>
<tr>
<td></td>
<td>a. Identify symptoms that indicate a machine is not operating properly (excessive noise, vibration, heat, speed, etc.).</td>
</tr>
<tr>
<td></td>
<td>b. Determine the cause of the symptoms.</td>
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<tr>
<td></td>
<td>c. Inspect machinery for broken or worn parts, and determine if replacement is needed.</td>
</tr>
<tr>
<td></td>
<td>d. Prepare a report on time and costs involved in repairing equipment.</td>
</tr>
<tr>
<td></td>
<td>e. Perform tagout-lockout procedures for broken equipment.</td>
</tr>
<tr>
<td></td>
<td>f. Disassemble, inspect, repair, and reassemble equipment to specifications.</td>
</tr>
<tr>
<td></td>
<td>g. Perform preventive maintenance on an electric motor (disassemble, clean and inspect, repair mechanical components, lubricate, and reassemble).</td>
</tr>
<tr>
<td></td>
<td>h. Check and service a battery, including recharging.</td>
</tr>
<tr>
<td>4.</td>
<td>Estimate expenses for a given project.</td>
</tr>
<tr>
<td></td>
<td>a. Prepare a bill of materials list for a specific job.</td>
</tr>
<tr>
<td></td>
<td>b. Calculate the labor factor for a specific job.</td>
</tr>
</tbody>
</table>

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### STANDARDS

*National Center for Construction Education and Research Standards*

- ELT4.8 HVAC Controls (Module 26408-11)
- IMM3.11 Hydraulic Controls (Module 40311-09)
- IMM3.12 Pneumatic Controls (Module 40312-09)
**Course Name:** Introduction to Sustainable and Renewable Energy

**Course Abbreviation:** ELT 2213

**Classification:** Career, Technical, and Associate Elective

**Description:** An introduction to alternative energy sources, such as wind, solar, bloom, wave, and hydroelectric applications. Installation techniques and power-transfer methods are also taught. (3 sch: 2-hr lecture, 2-hr lab)

**Prerequisite:** Fundamentals of Electricity (ELT 1192-3), AC/DC Circuits (ELT 1144), and Residential/Light Commercial Wiring (ELT 1113) or by permission of instructor

**Competencies and Suggested Objectives**

<table>
<thead>
<tr>
<th>1.</th>
<th>Apply general safety and safety requirements for working on and around electrical motors. DOK1, ELT4.7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a. Apply principles of safety in the use of electrical equipment and components.</td>
</tr>
<tr>
<td></td>
<td>b. Describe safety procedures to utilize during connecting and operating electrical equipment.</td>
</tr>
<tr>
<td>2.</td>
<td>Identify and explain different types of sustainable and renewable energy and the equipment needed in each process. DOK1, ELT4.7</td>
</tr>
<tr>
<td></td>
<td>a. Wind</td>
</tr>
<tr>
<td></td>
<td>b. Solar</td>
</tr>
<tr>
<td></td>
<td>c. Bloom</td>
</tr>
<tr>
<td></td>
<td>d. Wave Technology</td>
</tr>
<tr>
<td></td>
<td>e. Hydro Electric</td>
</tr>
<tr>
<td>3.</td>
<td>Demonstrate and explain the proper procedures for locating and installing sustainable and renewable energy devices. DOK1, ELT4.7</td>
</tr>
<tr>
<td></td>
<td>a. Wind</td>
</tr>
<tr>
<td></td>
<td>b. Solar</td>
</tr>
<tr>
<td>4.</td>
<td>Demonstrate and explain proper method of integrating power to the grid. DOK2, ELT4.7</td>
</tr>
<tr>
<td></td>
<td>a. Transfer switches/Sub-panels</td>
</tr>
<tr>
<td></td>
<td>b. Inverters</td>
</tr>
<tr>
<td></td>
<td>c. Voltage regulators</td>
</tr>
<tr>
<td></td>
<td>d. Battery banks</td>
</tr>
</tbody>
</table>

**STANDARDS**

*National Center for Construction Education and Research Standards*

ELT4.7 Advanced Controls (Module 26407-11)
Course Name: Solid State Motor Control

Course Abbreviation: ELT 2424

Classification: Career Elective (Certificate); Technical and Associate Core (Degree)

Description: Principles and operation of solid state motor control. Also, the design, installation, and maintenance of different solid state devices for motor control (4 sch: 2-hr lecture, 4-hr lab).

Prerequisite: Motor Control Systems (ELT 1413) and Programmable Logic Controllers (ELT 2613) or by permission of instructor

Competencies and Suggested Objectives

1. Apply general safety and safety requirements for working on and around electrical motors. DOK1, ELT4.7
   a. Apply principles of safety in the use of electrical motors.
   b. Describe safety procedures to utilize during connecting and operating electric motors.

2. Troubleshoot solid state motor controls. DOK2, ELT4.7
   a. Identify electronic and industrial symbols used to represent logic gates in solid state schematics.
   b. Describe the operation of the different types of industrial and electronic logic gates.
   c. Draw a solid state logic circuit to replace a manual control station.
   d. Troubleshoot and repair/replace solid state devices to include memory devices, flip/flops, adjustable time delays, starting and stopping sequences, and looping.

3. Operate AC and DC variable speed drives. DOK2, ELT4.7
   a. Discuss the operation of a DC variable speed drive.
   b. Discuss the operation of an AC variable speed drive.
   c. Connect and operate a DC and AC variable speed drive.

STANDARDS

National Center for Construction Education and Research Standards

ELT4.7 Advanced Controls (Module 26407-11)
Course Name: Programmable Logic Controllers

Course Abbreviation: ELT 2613

Classification: Career Elective (Certificate); Technical and Associate Core (Degree)

Description: Use of programmable logic controllers (PLCs) in modern industrial settings. Also, the operating principles of PLCs and practice in the programming, installation, and maintenance of PLCs (3 sch: 2-hr lecture, 2-hr lab.).

Prerequisite: Motor Control Systems (ELT 1413) or by permission of instructor

Competencies and Suggested Objectives

1. Explain principles of PLCs. DOK1, ELT3.11, ELT4.6, ELT4.7, ELT4.8
   a. Identify components and operational principles of PLCs.
   b. Differentiate between a PLC and a computer.

2. Identify different types of PLC hardware. DOK1, ELT3.11, ELT4.6, ELT4.7, ELT4.8
   a. Identify and wire different types of input and output modules.
   b. Identify different types of PLC processor modules, memory capabilities, and programming devices.

3. Explain numbering systems, encoding/decoding, and logical operations. DOK1, ELT3.11, ELT4.6, ELT4.7, ELT4.8
   a. Convert numbers from one system to another.
   b. Explain logical operations using truth tables and ladder logic diagrams.

4. Program all types of internal and discrete instructions. DOK2, ELT3.11, ELT4.6, ELT4.7, ELT4.8
   a. Program examine on and off instructions.
   b. Program on-delay and off-delay instructions.
   c. Program up-counter and down-counter instructions.
   d. Program sequencer instructions for real-world output devices.
   e. Program latch and unlatch instructions.

5. Troubleshoot and maintain different programmable controllers systems. DOK1, ELT3.11, ELT4.6, ELT4.7, ELT4.8
   a. Identify and troubleshoot the power supply.
   b. Identify and troubleshoot the inputs and outputs (I/O) cards.
   c. Identify and troubleshoot real-world inputs and outputs.

STANDARDS

National Center for Construction Education and Research Standards

ELT3.11 Motor Controls (Module 26311-11)
ELT4.6 Specialty Transformers (Module 26406-11)
ELT4.7 Advanced Controls (Module 26407-11)
ELT4.8 HVAC Controls (Module 26408-11)
Course Name: Advanced Programmable Logic Controllers

Course Abbreviation: ELT 2623

Classification: Career, Technical, and Associate Elective

Description: Advanced PLC course that provides instruction in the various operations, installations, and maintenance of electric motor controls. Also, information in such areas as sequencer, program control, introduction to function blocks, sequential function chart, introduction to HMI, and logical and conversion instructions (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Programmable Logic Controllers (ELT 2613) and Motor Control Systems (ELT 1413) or by permission of instructor

Competencies and Suggested Objectives

1. Program all types of high order instructions.  
   a. Calculate and develop mathematical instructions to include addition, subtraction, multiplication, and division.  
   b. Program and set up a chart for input and output sequencer combination.  
   c. Program and set up an analog input and output card using PLC software.  
   d. Explain the use of function block and sequential function blocks in a programmable logic controller.  
   e. Demonstrate the ability to develop a basic Human to Machine Interface (HMI) project.  
   f. Program and demonstrate how to set up a produce and consume tag/message.

2. Troubleshoot advanced PLC controls.  
   a. Troubleshoot an analog input and output card.  
   b. Troubleshoot communication devices used in networking.

STANDARDS

National Center for Construction Education and Research Standards

ELT3.11 Motor Controls (Module 26311-11)  
ELT4.6 Specialty Transformers (Module 26406-11)  
ELT4.7 Advanced Controls (Module 26407-11)  
ELT4.8 HVAC Controls (Module 26408-11)
Course Name: Special Project I, II

Course Abbreviation: ELT 291(1-3), ELT 293(1-3)

Classification: Career, Technical, and Associate Elective

Description: Practical application of skills and knowledge gained in other electrical or electrical-related technical courses. The instructor works closely with the student to ensure that the selection of a project will enhance the student’s learning experience. (1–3 sch: 2–6-hr lab)

Prerequisite: Consent of instructor

Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Develop a written plan and blueprints that detail the activities and projects to be completed.</td>
</tr>
<tr>
<td>a. Utilize a written plan that details the activities and projects to be completed.</td>
</tr>
<tr>
<td>b. Perform written occupational objectives in the special project.</td>
</tr>
<tr>
<td>2. Assess accomplishment of objectives.</td>
</tr>
<tr>
<td>a. Prepare daily written assessment of accomplishment of objectives.</td>
</tr>
<tr>
<td>b. Present weekly written reports to the instructor in activities performed and objectives accomplished.</td>
</tr>
<tr>
<td>3. Utilize a set of written guidelines for the special project.</td>
</tr>
<tr>
<td>a. Develop and follow a set of written guidelines for the special project.</td>
</tr>
</tbody>
</table>

STANDARDS

Specific standards for this course will depend upon the nature of the problem under investigation.
Course Name: Supervised Work Experience I, II
Course Abbreviation: ELT 292(1-6), ELT 294(1-6)

Classification: Career, Technical, and Associate Elective

Description: A cooperative program between industry and education that is designed to integrate the student’s technical studies with industrial experience. Variable credit is awarded on the basis of 1 semester credit hour (sch) per 45 industrial contact hours. (1–6 sch: 3–18-hr externship)

Prerequisite: Consent of instructor and completion of at least one semester of advanced coursework in electrical/electronics related programs

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Apply technical skills needed to be a viable member of the workforce.</td>
</tr>
<tr>
<td>a. Prepare a description of technical skills to be developed in the supervised work experience program.</td>
</tr>
<tr>
<td>b. Develop technical skills needed to be a viable member of the workforce.</td>
</tr>
<tr>
<td>2. Apply skills developed in other program area courses.</td>
</tr>
<tr>
<td>a. Perform skills developed in other program area courses in the supervised work experience program.</td>
</tr>
<tr>
<td>3. Apply human relationship skills.</td>
</tr>
<tr>
<td>a. Practice human relationship skills in the supervised work experience program.</td>
</tr>
<tr>
<td>4. Apply and practice positive work habits and responsibilities.</td>
</tr>
<tr>
<td>a. Perform assignments to develop positive work habits and responsibilities.</td>
</tr>
<tr>
<td>5. Work with the instructor and employer to develop written occupational objectives to be accomplished.</td>
</tr>
<tr>
<td>a. Perform written occupational objectives in the supervised occupational experience program.</td>
</tr>
<tr>
<td>6. Assess accomplishment of objectives.</td>
</tr>
<tr>
<td>a. Prepare daily written assessment of accomplishment of objectives.</td>
</tr>
<tr>
<td>b. Present weekly written reports to instructor in activities performed and objectives accomplished.</td>
</tr>
<tr>
<td>7. Utilize a set of written guidelines for the supervised work experience.</td>
</tr>
<tr>
<td>a. Develop and follow a set of written guidelines for the supervised work experience.</td>
</tr>
</tbody>
</table>

STANDARDS

Specific standards for this course will depend upon the nature of the problem under investigation.
**Course Name:** Fundamentals of Construction and Manufacturing

**Course Abbreviation:** CTE 1143

**Classification:** Career, Technical, and Associate Core/Elective (This course may be taught as an elective or a core course. Please refer to the course sequence in the appropriate curriculum to determine the classification of this course.)

**Description:** This course includes basic safety, an introduction to construction math, an introduction to hand and power tools, an introduction to construction drawings, employability skills and communications. (Approximately 72.5 clock hours should be allotted in this course to satisfy requirements to test for NCCER Core certification. Instructors for this course must be certified as an NCCER Instructor.) (3 sch: 2 hr. lecture, 2 hr. lab)

**Prerequisites:** None

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### Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong> Describe general safety rules for working in a shop/lab and industry.</td>
</tr>
<tr>
<td>a. Describe how to avoid on-site accidents.</td>
</tr>
<tr>
<td>b. Explain the relationship between housekeeping and safety.</td>
</tr>
<tr>
<td>c. Explain the importance of following all safety rules and company safety policies according to OSHA standards including addressing General Duty Clause and 1926 CFR Subpart C.</td>
</tr>
<tr>
<td>d. Explain the importance of reporting all on-the-job injuries, accidents, and near misses.</td>
</tr>
<tr>
<td>e. Explain the need for evacuation policies and the importance of following them.</td>
</tr>
<tr>
<td>f. Explain the employer’s substances abuse policy and how it relates to safety.</td>
</tr>
<tr>
<td>g. Explain the safety procedures when working near pressurized or high temperature.</td>
</tr>
<tr>
<td>h. Use proper safety practices when working around welding operations.</td>
</tr>
<tr>
<td>i. Use proper safety practices when working in or near trenches and excavations.</td>
</tr>
<tr>
<td>j. Explain the term <strong>proximity work</strong>.</td>
</tr>
</tbody>
</table>

| **2.** Identify and explain use of various barriers and confinements |
| a. Explain the safety requirements for working in confined areas. |
| b. Explain and practice lockout/tagout procedures. |
| c. Explain the different barriers and barricades, and how they are used. |
| d. Recognize and explain personal protective equipment. |
| e. Inspect and care for personal protective equipment. |

| **3.** Explain lifting, fall protection, and the use of ladders and scaffolds. |
| a. Identify and explain the procedures for lifting heavy objects. |
| b. Explain fall protection procedures. |
| c. Inspect and safely work with various ladders and scaffolds. |

| **4.** Explain the Material Safety Data Sheet (MSDS). |
| a. Explain the function of the MSDS. |
| b. Interpret the requirements of the MSDS. |
| c. Discuss hazardous material exposures. |

| **5.** Display appropriate safety procedures related to fires. |
### 6. Explain safety in and around electrical situations.  
- Explain injuries when electrical contact occurs. 
- Explain safety around electrical hazards. 
- Explain action to take when an electrical shock occurs.

### 7. Apply basic mathematics for residential carpentry.  
- Apply the four basic math skills with whole numbers, fractions, and percent. 
- Use the metric system. 
- Identify and read measuring tools. 
- Solve basic algebraic equations. 
- Calculate area and volume of simple geometric figures. 
- Apply basic math to solve simple geometric figures and problems.

### 8. Demonstrate the use and maintenance of hand and power tools.  
- Identify and discuss the use of common hand and power tools. 
- Discuss rules of safety for hand and power tools. 
- Select and demonstrate the use of tools. 
- Explain the procedures for maintenance.

### 9. Read, analyze, and design a construction drawing.  
- Recognize and identify terms, components, and symbols commonly used on blueprints. 
- Relate information on construction drawings to actual locations on the print. 
- Recognize different classifications of drawing. 
- Interpret and use drawing dimensions.

### 10. Safely handle and store materials.  
- Define a load. 
- Establish a pre-task plan prior to moving a load. 
- Use proper materials-handling techniques. 
- Choose appropriate materials-handling equipment for the task. 
- Recognize hazards and follow safety procedures required for materials handling.

### 11. Describe employment opportunities and responsibilities.  
- Describe employment opportunities including potential earnings, employee benefits, job availability, places of employment, working conditions, and educational requirements. 
- Describe basic employee responsibilities.

### 12. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations.  

### OPTIONAL COMPETENCY:  
### 13. Explain and identify safe rigging and equipment.  
- Explain and practice safe rigging. 
- Identify and explain rigging equipment. 
- Inspect rigging equipment.
NCCER Learning Series Standards

**NCCER Core**

BSM – BASIC SAFETY (00101-09)

ICM – INTRODUCTION TO CONSTRUCTION MATH (00102-09)

IHT – INTRODUCTION TO HAND TOOLS (00103-09)

IPT – INTRODUCTION TO POWER TOOLS (00104-09)

BLU – INTRODUCTION TO CONSTRUCTION DRAWINGS (00105-09)

COM – BASIC COMMUNICATION SKILLS (00107-09)

EMP – BASIC EMPLOYABILITY SKILLS (00108-09)

IMH – INTRODUCTION TO MATERIALS HANDLING (00109-09)

RIG – BASIC RIGGING (00106-09)
Course Name: Computational Methods for Career and Technical Education

Course Abbreviation: CTE 1153

Classification: Career, Technical, and Associate Elective

Description: Study of computational skills required for the development of accurate design and drafting methods used in technology based professions. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: None

Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>1. Demonstrate various measurement methods. [DOK1]</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Measure distances, including metric and English measurements.</td>
</tr>
<tr>
<td>b. Measure angles, including decimal degrees and degrees, minutes, and seconds.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Apply industry data. [DOK2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Interpret graphs and charts.</td>
</tr>
<tr>
<td>b. Manipulate gathered information.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. Analyze complex geometric shapes. [DOK2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Calculate area using metric and English systems.</td>
</tr>
<tr>
<td>b. Calculate volume using metric and English systems.</td>
</tr>
<tr>
<td>c. Solve geometric construction based on area/volume solutions.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. Calculate trigometric values. [DOK2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Calculate angle values of a triangle.</td>
</tr>
<tr>
<td>b. Solve geometric construction based on angular solutions.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. Calculate industry expenses. [DOK2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Prepare a cost analysis.</td>
</tr>
<tr>
<td>b. Compute overhead expenses.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6. General mathematics. [DOK2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Use a calculator.</td>
</tr>
<tr>
<td>b. Solve basic algebraic equations and conversions from fraction to decimal and metric.</td>
</tr>
</tbody>
</table>

STANDARDS

Specific standards will be determined by the national standards aligned to the individual program area utilizing this course.

SUGGESTED REFERENCES

References will be determined by content unique to the program area utilizing this course.
Course Name: Introduction to Sustainable and Renewable Energy

Course Abbreviation: CTE 1163

Classification: Career, Technical, and Associate Elective

Description: An introduction to alternative energy sources, such as wind, solar, bloom, wave, and hydroelectric applications. Installation techniques and power-transfer methods are also taught. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: None

Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>Competencies</th>
<th>Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Apply general safety and safety requirements for working on and around electrical motors. DOK1</td>
</tr>
<tr>
<td></td>
<td>a. Apply principles of safety in the use of electrical equipment and components.</td>
</tr>
<tr>
<td></td>
<td>b. Describe safety procedures to utilize during connecting and operating electrical equipment.</td>
</tr>
<tr>
<td>2.</td>
<td>Identify and explain different types of sustainable and renewable energy and the equipment needed in each process. DOK1</td>
</tr>
<tr>
<td></td>
<td>a. Wind</td>
</tr>
<tr>
<td></td>
<td>b. Solar</td>
</tr>
<tr>
<td></td>
<td>c. Bloom</td>
</tr>
<tr>
<td></td>
<td>d. Wave Technology</td>
</tr>
<tr>
<td></td>
<td>e. Hydro Electric DOK1</td>
</tr>
<tr>
<td>3.</td>
<td>Demonstrate and explain the proper procedures for locating and installing sustainable and renewable energy devices. DOK17</td>
</tr>
<tr>
<td></td>
<td>a. Wind</td>
</tr>
<tr>
<td></td>
<td>b. Solar</td>
</tr>
<tr>
<td>4.</td>
<td>Demonstrate and explain proper method of integrating power to the grid. DOK2</td>
</tr>
<tr>
<td></td>
<td>a. Transfer switches/Sub-panels</td>
</tr>
<tr>
<td></td>
<td>b. Inverters</td>
</tr>
<tr>
<td></td>
<td>c. Voltage regulators</td>
</tr>
<tr>
<td></td>
<td>d. Battery banks</td>
</tr>
</tbody>
</table>

STANDARDS

Specific standards will be determined by the national standards aligned to the individual program area utilizing this course.

SUGGESTED REFERENCES

References will be determined by content unique to the program area utilizing this course.
Appendix A: Course References

All of the Electrical Technology courses use the same resources for each course. You will find suggested resources listed below.

**ELT 1113**


**Course Name:** Commercial and Industrial Wiring

**Course Abbreviation:** ELT 1123

**Classification:** Vocational–Technical Core

**Description:** Instruction and practice in the installation of commercial and industrial electrical services including the types of conduit and other raceways, NEC code requirements, and three-phase distribution networks. (3 sch: 2-hr lecture, 2-hr lab)

**Prerequisites:** Fundamentals of Electricity (ELT 1192-3), Residential/Light Commercial Wiring (ELT 1113), or by permission of instructor

---

**Competencies and Suggested Objectives**

1. Apply general safety rules and current NEC and local codes.
   - a. Explain and demonstrate safety rules and regulations for working near or on load centers and safety switches.
   - b. Explain and demonstrate the ability of safe lifting and work habits.
   - c. Identify the code requirements for industrial and commercial locations.

2. Install and maintain raceways, conduit, and fittings.
   - a. Identify types of raceways, conduit, and fittings.
   - b. Apply usage of raceways, conduit, and fittings as required by electrical codes.
   - c. Demonstrate the use of mechanical and hydraulic conduit benders to make specified bends to different sizes and types of conduit.
   - d. Identify other types of raceways and their associated bodies.

3. Explain different types of three-phase service entrances, metering devices, main panels, raceways or ducts, subpanels, feeder circuits, and branch circuits according to electrical codes.
   - a. Explain the codes (NEC and local codes) for the installation of a three-phase service entrance.
b. Explain safety precautions to be used when installing a three-phase service entrance.

c. Construct a sketch to install a three-phase service entrance.

d. Explain terms associated with a three-phase service entrance from codes and industry terminology.

e. Identify components of a three-phase service entrance.

4. Prepare a job estimate including supplies and labor costs.

   a. Compute the local labor cost for a given job.

   b. Determine amount of supplies for a given job.

   c. Compute the cost of supplies for a given job.

   d. Justify in writing the total cost for a given job.

STANDARDS

_National Center for Construction Education and Research Standards_

ELT1.7 Hand Bending

ELT1.8 Raceways, Boxes, and Fittings

ELT2.6 Conductor Installations
Related Academic Standards

C1 Interpret written material.
C2 Interpret visual materials (maps, charts, graphs, tables, etc.).
C3 Listen, comprehend, and take appropriate actions.
C4 Access, organize, and evaluate information.
C5 Use written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.
C6 Communicate ideas and information effectively using various oral and written forms for a variety of audiences and purposes.
M1 Relate number relationships, number systems, and number theory.
M2 Explore patterns and functions.
M7 Apply mathematical methods, concepts, and properties to solve a variety of real-world problems.
S8 Apply concepts related to the scientific process and method to include safety procedures for classroom and laboratory; use and care of scientific equipment; interrelationships between science, technology, and society; and effective communication of scientific results in oral, written, and graphic form.

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21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
International and Self-Directional Skills

National Educational Technology Standards for Students

T1 Basic operations and concepts
T3 Technology productivity tools
T4 Technology communications tools
T5 Technology research tools
T6 Technology problem-solving and decision-making tools

SUGGESTED REFERENCES


Course Name: Introduction to the National Electric Code

Course Abbreviations: ELT 1133

Classification: Vocational–Technical Elective

Description: This is a course in the layout, format, rules, and regulations set forth in the National Electric Code. Emphasis is placed on developing the student’s ability to find information in the National Electric Code and applying that information in real-world applications. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisites: None

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Use the NEC as a reference manual to locate information and give a reference of where the information can be found.</td>
</tr>
<tr>
<td>a. Find and interpret the requirements for installing various electrical equipment and conductors in dry, damp, and wet locations.</td>
</tr>
<tr>
<td>b. Calculate the size of the current carry conductors needed to supply a circuit.</td>
</tr>
<tr>
<td>c. Calculate the current carrying capabilities of conductors with variances in the number of conductors in a raceway and changes in ambient temperature.</td>
</tr>
<tr>
<td>d. Calculate the size of service conductors for the ungrounded, grounded, and grounding conductor.</td>
</tr>
<tr>
<td>e. Calculate the number of specific current carry conductors that can be installed in a raceway.</td>
</tr>
</tbody>
</table>

STANDARDS

National Center for Construction Education and Research Standards

ELT1.5—Introduction to the National Electrical Code


**Related Academic Standards**

C1——Interpret written material.

C2——Interpret visual materials (maps, charts, graphs, tables, etc.).

C3——Listen, comprehend, and take appropriate actions.

C4——Access, organize, and evaluate information.

M1——Relate number relationships, number systems, and number theory.

M4——Explore the concepts of measurement.

M7——Apply mathematical methods, concepts, and properties to solve a variety of real-world problems.

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**21st Century Skills**

CS1——Global Awareness

CS2——Financial, Economic, and Business Literacy

CS3——Civic Literacy

CS4——Information and Communication Skills

CS5——Thinking and Problem-Solving Skills

CS6——Interpersonal and Self-Directional Skills

**National Educational Technology Standards for Students**

T1——Basic operations and concepts
T3 Technology productivity tools
T4 Technology communications tools
T5 Technology research tools
T6 Technology problem-solving and decision-making tools

SUGGESTED REFERENCES


Course Name: AC and DC Circuits for Electrical Technology

Course Abbreviation: ELT 1144

Classification: Vocational–Technical Core

Description: Principles and theories associated with AC and DC circuits used in the electrical trades. Includes the study of electrical circuits, laws and formulas, and the use of test equipment to analyze AC and DC circuits (4 sch: 2-hr lecture, 4-hr lab)

Pre/Corequisites: Fundamentals of Electricity (ELT 1192-3) or by permission of instructor

Competencies and Suggested Objectives

1. Demonstrate and practice general safety procedures in the school and work site environments.
   a. Apply relevant and appropriate safety techniques.
   b. Demonstrate and comply with relevant OSHA safety standards.

2. Demonstrate and apply a basic electrical circuit:
   a. Write numbers in scientific and engineering notation.
   b. Perform mathematical manipulations with numbers expressed in engineering notation.
   c. Explain the basic structure of matter to include the atom and element.
   d. Explain the laws of electrical charge.
   e. Differentiate among the characteristics of conductors, semiconductors, and insulators.
   f. Demonstrate the ability to determine resistor types, value, tolerance, and power rating.
   g. Demonstrate proper techniques for measuring resistance.
   h. Discuss methods of generating electricity.
   i. Explain theories of current flow including electron and conventional method.
<p>| | |</p>
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<tbody>
<tr>
<td><strong>j.</strong></td>
<td>Demonstrate principles of and operation of batteries.</td>
</tr>
<tr>
<td><strong>k.</strong></td>
<td>Explain and demonstrate measurement of resistance of conductors and insulators and the computation of conductance.</td>
</tr>
</tbody>
</table>

3. Demonstrate the meaning of and relationships among and between voltage, current, resistance, and power in AC and DC circuits.

   a. Explain the relationship between voltage, current, and resistance in AC and DC circuits.
   b. State three equations used to express Ohm’s law.
   c. Analyze circuit parameters using Ohm’s law.
   d. Explain how power is developed in a circuit.
   e. State three forms of power equations.
   f. Demonstrate techniques for determining a power.
   g. Explain proper techniques for connecting a voltmeter to measure voltage.
   h. Explain proper techniques for connecting current meter to measure current.
   i. Measure voltage.
   j. Measure resistance.
   k. Measure current.
4. Analyze and evaluate the parameters of AC and DC series circuits.

   a. Identify series circuits.
   b. Compute total resistance of a series circuit.
   c. Compute current in a series circuit using Ohm’s law.
   d. Explain why current is the same at all points in a series circuit.
   e. State and apply Kirchhoff’s Voltage Law in analysis of series circuits.
   f. Explain why series circuits are known as a voltage divider.
   g. Compute voltage drops in a series circuit using Ohm’s law.
   h. Compute the power developed by each resistor and the total power of a series circuit.
   i. Explain the difference between series-aiding and series-opposing voltage sources.
   j. Construct, analyze, and troubleshoot a series circuit.

5. Analyze and evaluate the parameters of AC and DC parallel circuits.

   a. Identify parallel circuits.
   b. Compute total resistance of a parallel circuit.
   c. Utilize Ohm’s law to solve circuit parameters of parallel DC circuit.
   d. Explain why voltage is the same across all branches of a parallel circuit.
   e. State and apply Kirchhoff’s Current Law in the analysis of parallel circuit.
   f. Explain why a parallel circuit is a current divider.
   g. Compute branch currents in a parallel resistive circuit using the current divider equation.

6. Analyze and evaluate the parameters of AC and DC series-parallel circuit.

   c. Analyze series-parallel circuits for the current through and the voltage across each component.
   d. Construct, analyze, and troubleshoot a series-parallel circuit.
7. Analyze inductive and capacitive reactance in series and parallel circuits.
   a. Calculate inductive reactance (X_l) using Ohm’s law or the inductive reactance formula when signal frequency and inductance are known.
   b. Solve for signal frequency when inductance and inductive reactance are known or inductance when frequency and inductive reactance are known.
   c. Calculate capacitive reactance (X_c) using Ohm’s law or the capacitive reactance formula when signal frequency and capacitance are known.
   d. Solve for signal frequency when capacitance and capacitive reactance are known or capacitance when frequency and capacitive reactance are known.
   e. Calculate all voltages and currents in series and parallel capacitive and inductive circuits.

8. Analyze transformer voltage, current, impedance transformations, and applications.
   a. Explain how mutual inductance affects transformer action.
   b. Calculate primary and secondary transformer voltage and current as related to the transformer’s turns ratio.
   c. Explain the theory of reflected impedance between the primary and secondary, or secondaries, of transformers.
   d. Calculate reflected impedance given a transformer turns ratio and secondary load impedance.
   e. Explain various transformer ratings, such as voltage, current, power, impedance, frequency, and efficiency.
   f. Explain various transformer losses such as winding losses and core losses.
   g. Discuss a variety of transformer types and applications.
   h. Construct transformer circuits, and measure voltages and currents as calculated.
   i. Troubleshoot a transformer using an ohmmeter and/or voltmeter.

STANDARDS

National Center for Construction Education and Research Standards
ELT1.4 Electrical Theory

ELT1.12 Electrical Test Equipment

ELT2.1 Alternating Current

Related Academic Standards

C1 Interpret written material.

C2 Interpret visual materials (maps, charts, graphs, tables, etc.).

C3 Listen, comprehend, and take appropriate actions.

C4 Access, organize, and evaluate information.

C5 Use written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.

C6 Communicate ideas and information effectively using various oral and written forms for a variety of audiences and purposes.

M1 Relate number relationships, number systems, and number theory.

M2 Explore patterns and functions.

M3 Explore algebraic concepts and processes.

M4 Explore the concepts of measurement.

M6 Explore concepts of statistics and probability in real-world situations.

M7 Apply mathematical methods, concepts, and properties to solve a variety of real-world problems.

S5 Investigate the properties and reactions of matter to include symbols, formulas and nomenclature, chemical equations, gas laws, chemical bonding, acid-based reactions, equilibrium, oxidation-reduction, nuclear chemistry, and organic chemistry.

S6 Explore the principles and theories related to motion, mechanics, electricity, magnetism, light energy, thermal energy, wave energy, and nuclear physics.
S8—— Apply concepts related to the scientific process and method to include safety procedures for 
classroom and laboratory; use and care of scientific equipment; interrelationships between 
science, technology, and society; and effective communication of scientific results in oral, 
written, and graphic form.

SUGGESTED REFERENCES


**Course Name:** Drafting for Electrical Technology

**Course Abbreviation:** ELT 1163

**Classification:** Vocational–Technical Elective

**Description:** Preparation and interpretation of schematics and electrical drawing and electrical blueprints (3 sch: 1-hr lecture, 4-hr lab)

**Pre/Corequisites:** Fundamentals of Electricity ELT 1192, Blueprint Reading ELT 1263, Estimating Cost ELT 1283, or by permission of instructor
## Competencies and Suggested Objectives

1. Demonstrate an understanding of drafting fundamentals utilizing both hand- and computer-aided drafting and how it relates to the electrical industry.
   a. Explain the need for national drafting standards.
   b. Explain the need for drawing quality and standard drawing sizes.
   c. Explain the requirements for lettering and different line widths.
   d. Discuss computer-aided design (CAD).

2. Demonstrate an understanding of electrical symbols, components, and references used in schematic and logic diagrams.
   a. Identify components by symbol.
   b. Draw component and schematic symbols to drafting standards.
   c. Correctly use component references and values.
   d. Use symbols in schematic diagrams.
   e. Interpret logic symbols.
   f. Create formal drawings from an engineering sketch.

3. Demonstrate the ability to compose projections and electrical drawings and diagrams.
   a. Define and identify a perspective drawing.
   b. Define and create orthographic, isometric, and oblique drawings.
   c. Apply rules of good dimensioning to mechanical drawing.
   d. Create printed circuit board assembly drawings.
   e. Create block, flow, and single line diagrams.
   f. Create schematic and logic diagrams.
   g. Create point-to-point and pictorial point-to-point diagrams.
   h. Create cable assemblies and interconnection diagrams.

4. Demonstrate an understanding of electronics drafting using CAD.
   a. Create electronic symbols to drafting standards.
b. Insert symbols into drawings.
c. Use CAD commands to create drawings and schematic diagrams.

STANDARDS

National Center for Construction Education and Research Standards

ELT1.10 Basic Electrical Construction Drawings

Related Academic Standards

C1——Interpret written material.
C2——Interpret visual materials (maps, charts, graphs, tables, etc.).
C5——Use written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.
C6——Communicate ideas and information effectively using various oral and written forms for a variety of audiences and purposes.
M4——Explore the concepts of measurement.
M5——Explore the geometry of one-, two-, and three-dimensions.

21st Century Skills

CS1——Global Awareness
CS2——Financial, Economic, and Business Literacy
CS3——Civic Literacy
CS4——Information and Communication Skills
CS5——Thinking and Problem-Solving Skills
CS6——Interpersonal and Self-Directional Skills

National Educational Technology Standards for Students

T1——Basic operations and concepts
T2——Social, ethical, and human issues
T3——Technology productivity tools
T4——Technology communications tools
T5——Technology research tools

T6——Technology problem-solving and decision-making tools

Suggested References


**Course Name:** Fundamentals of Electricity

**Course Abbreviation:** ELT 1192-3

**Classification:** Vocational–Technical Core

**Description:** Fundamental skills associated with all electrical courses. Safety, basic tools, special tools, equipment, and introduction to simple AC and DC circuits (2 sch.: 1-hr lecture, 2-hr lab)

**Prerequisites:** None

### Competencies and Suggested Objectives

1. Apply general safety procedures in the shop, lab, and industrial environment.
   - a. Apply proper safety techniques for all types of circuits and components.
   - b. Demonstrate an understanding of and comply with relevant OSHA safety standards.
   - c. Demonstrate the use of lockout and tagout electrical procedures.

2. Demonstrate use of electrical tools, equipment, and references.
   - a. Identify and demonstrate proper use of basic tools. Identify and demonstrate proper use of basic equipment including meters, drills, threaders, conduit benders, and other equipment.
   - b. Demonstrate the use of and reading of a rule, tape, and architectural scale.
   - c. Locate and interpret information in the NEC relative to a specific job.

3. Solve problems using Ohm’s law.
   - a. List three formulae for Ohm’s law.
   - b. Solve problems for an unknown voltage, amperage, resistance, and wattage.
STANDARDS

National Center for Construction Education and Research Standards

ELT1.2—Electrical Safety
ELT1.4—Electrical Theory
ELT1.5—Introduction to the National Electrical Code
ELT1.12 Electrical Test Equipment

Related Academic Standards

C1——Interpret written material.
C2——Interpret visual materials (maps, charts, graphs, tables, etc.).
C3——Listen, comprehend, and take appropriate actions.
C5——Use written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.
C6——Communicate ideas and information effectively using various oral and written forms for a variety of audiences and purposes.
M1——Relate number relationships, number systems, and number theory.
M2——Explore patterns and functions.
M4——Explore the concepts of measurement.
M7——Apply mathematical methods, concepts, and properties to solve a variety of real-world problems.
S8——Apply concepts related to the scientific process and method to include safety procedures for classroom and laboratory; use and care of scientific equipment; interrelationships between science, technology, and society; and effective communication of scientific results in oral, written, and graphic form.

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21st Century Skills

CS1—Global Awareness
CS2—Financial, Economic, and Business Literacy
CS3—Civic Literacy
CS4—Information and Communication Skills
CS5—Thinking and Problem-Solving Skills
CS6—Interpersonal and Self-Directional Skills

National Educational Technology Standards for Students

T1—Basic operations and concepts
T3—Technology productivity tools
T4—Technology communications tools
T5—Technology research tools
T6—Technology problem-solving and decision-making tools

Suggested References


Course Name: Electrical Power

Course Abbreviation: ELT 1213

Classification: Vocational–Technical Core

Description: Electrical motors and their installation. Instruction and practice in using the different types of motors, transformers, and alternators (3 sch.: 2-hr lecture, 2-hr lab)

Pre/Corequisites: Fundamentals of Electricity (ELT 1192-3) or by permission of instructor

Competencies and Suggested Objectives

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1.</td>
<td>Discuss safety and environmental protection concerns associated with electrical power equipment.</td>
</tr>
<tr>
<td></td>
<td>a. List safety precautions associated with motors and transformers.</td>
</tr>
<tr>
<td></td>
<td>b. Explain the procedures for working with and disposing of hazardous materials.</td>
</tr>
<tr>
<td>2.</td>
<td>Wire single-phase electrical components.</td>
</tr>
<tr>
<td></td>
<td>a. Sketch and connect a single-phase transformer for high- and low-voltage applications.</td>
</tr>
<tr>
<td></td>
<td>b. Identify, sketch, and wire different types of single-phase motors.</td>
</tr>
<tr>
<td></td>
<td>c. Explain and demonstrate the applications of an AC generator.</td>
</tr>
<tr>
<td>3.</td>
<td>Wire three-phase electrical components.</td>
</tr>
<tr>
<td></td>
<td>a. Sketch and connect a three-phase AC transformer to include delta and wye and three-wire and four-wire systems.</td>
</tr>
<tr>
<td></td>
<td>b. Identify, draw, and wire different types of three-phase motors to include low and high voltage requirements.</td>
</tr>
</tbody>
</table>
STANDARDS

National Center for Construction Education and Research Standards

ELT2.2 Motors: Theory and Application
ELT3.7 Transformers

Related Academic Standards

C1 Interpret written material.
C2 Interpret visual materials (maps, charts, graphs, tables, etc.).
C3 Listen, comprehend, and take appropriate actions.
C4 Access, organize, and evaluate information.
C5 Use written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.
C6 Communicate ideas and information effectively using various oral and written forms for a variety of audiences and purposes.
M7 Apply mathematical methods, concepts, and properties to solve a variety of real-world problems.
S6 Explore the principles and theories related to motion, mechanics, electricity, magnetism, light energy, thermal energy, wave energy, and nuclear physics.
S8 Apply concepts related to the scientific process and method to include safety procedures for classroom and laboratory; use and care of scientific equipment; interrelationships between science, technology, and society; and effective communication of scientific results in oral, written, and graphic form.

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21st Century Skills

CS1——Global Awareness
CS2——Financial, Economic, and Business Literacy
CS3——Civic Literacy
CS4——Information and Communication Skills
CS5——Thinking and Problem-Solving Skills
CS6——Interpersonal and Self-Directional Skills

National Educational Technology Standards for Students

T1——Basic operations and concepts
T3——Technology productivity tools
T4——Technology communications tools
T5——Technology research tools
T6——Technology problem-solving and decision-making tools

SUGGESTED REFERENCES


Course Name: Motor Maintenance and Troubleshooting

Course Abbreviation: **ELT 1223**

Classification: Vocational–Technical Core (Associate degree) or Vocational–Technical Elective (Certificate)

Description: Principles and practice of electrical motor repair. Includes topics on the disassembly/assembly and preventive maintenance of common electrical motors (3 sch: 2-hr lecture, 2-hr lab)

Prerequisites: Fundamentals of Electricity (ELT 1192-3) or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Apply general safety and safety requirements for working with electric motors.</td>
</tr>
<tr>
<td>a. Apply principles of safety in the use and repair of electrical motors.</td>
</tr>
<tr>
<td>b. Describe safety procedures to utilize during connecting, operating, and repairing of electrical motors.</td>
</tr>
<tr>
<td>c. Practice lockout/tagout procedure.</td>
</tr>
<tr>
<td>2. Use instruments and tools in maintaining, troubleshooting, and operating electrical motors.</td>
</tr>
<tr>
<td>a. Identify, describe, and demonstrate the use of instruments and tools used to maintain, troubleshoot, and repair motors to include megohm meters, volt-amp meters, and multimeters.</td>
</tr>
<tr>
<td>b. Describe the procedures for the maintenance, testing, and/or repair of instruments and tools.</td>
</tr>
<tr>
<td>3. Troubleshoot and perform basic maintenance on electrical motors.</td>
</tr>
<tr>
<td>a. List and describe functions of the major parts and windings of single-phase motors.</td>
</tr>
<tr>
<td>b. List and describe the functions of split-phase, capacitor start, capacitor start-capacitor run,</td>
</tr>
</tbody>
</table>
and permanent split capacitor electric motors.

c. Describe and list the functions of a shaded pole and repulsion/induction electric motors.

d. List and describe functions of major parts and windings of three-phase motors to include squirrel cage induction, synchronous, and wound rotor motors.

e. List and describe functions of the major parts and windings of DC motors to include series, shunt, and compound wound motors.

f. Develop a preventive maintenance program for electric motors.

STANDARDS

National Center for Construction Education and Research Standards

ELT4.10 Motor Operation and Maintenance

Related Academic Standards

C1—— Interpret written material.

C2—— Interpret visual materials (maps, charts, graphs, tables, etc.).

C3—— Listen, comprehend, and take appropriate actions.

C4—— Access, organize, and evaluate information.

C5—— Use written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.

C6—— Communicate ideas and information effectively using various oral and written forms for a variety of audiences and purposes.

S8—— Apply concepts related to the scientific process and method to include safety procedures for classroom and laboratory; use and care of scientific equipment; interrelationships between science, technology, and society; and effective communication of scientific results in oral, written, and graphic form.
21st Century Skills

CS1—Global Awareness
CS2—Financial, Economic, and Business Literacy
CS3—Civic Literacy
CS4—Information and Communication Skills
CS5—Thinking and Problem-Solving Skills
CS6—Interpersonal and Self-Directional Skills

National Educational Technology Standards for Students

T1—Basic operations and concepts
T3—Technology productivity tools
T4—Technology communications tools
T5—Technology research tools
T6—Technology problem-solving and decision-making tools

SUGGESTED REFERENCES


**Course Name:**

**ELT 1253 Branch Circuit and Service Entrance Calculations**

**Course Abbreviation:** ELT-1253

**Classification:** Vocational–Technical Core (Certificate) or Vocational–Technical Elective (Associate degree)

**Description:** Calculating circuit sizes for all branch circuits and service entrances in residential installation (3 sch.: 2-hr lecture, 2-hr lab)

**Pre/Corequisites:** Residential/Light Commercial Wiring (ELT 1113) or by permission of instructor

**Competencies and Suggested Objectives**

1. Explain size and color of equipment grounding conductors for all branch circuits.

   a. Explain the different colors of equipment grounding conductors for all branch circuits.

   b. Explain the equipment grounding conductor sizes in relationship to the rating or setting of the automatic overcurrent device ahead of the equipment (per NEC).
2. Determine the minimum number of general purpose branch circuits needed in a residential structure.
   a. Calculate the usable square footage of a dwelling for general purpose application.
   b. Compute the minimum wattage by NEC standards for total watts for general purpose lighting and appliance circuits.
   c. Compute the minimum number of 15-A or 20-A general purpose branch circuits.

3. Calculate the branch circuit sizes for individual branch circuits for residential wiring.
   a. Calculate the branch circuit conductor size for motors according to NEC.
   b. Calculate the branch circuit conductor size for air conditioning and refrigeration equipment according to NEC.
   c. Calculate the branch circuit size for appliances according to NEC.
   d. Calculate the branch circuit size for heat according to NEC.

4. Calculate the minimum number of branch circuits of the small appliance and laundry types.
   a. Explain the circuit size and specified area use of the small appliance and laundry branch circuits.
   b. Explain the exceptions permitted by the NEC as to circuit area usage of small appliance branch circuits.

5. Explain and demonstrate the procedure for calculating the residential service entrance conductor size using the standard or optional method according to NEC.
   a. Calculate the wattage of the small appliance and laundry circuits as specified in NEC.
   b. Calculate the wattage of general purpose branch circuits as specified in NEC.
   c. Calculate the wattage of all appliances that may be permanently connected or on a specific circuit.
   d. Demonstrate the procedure for calculating the heat and air-conditioning load as specified in NEC.
STANDARDS

National Center for Construction Education and Research Standards

ELT2.9 Grounding and Bonding

ELT3.1 Load Calculators—Branch and Feeder Circuits

ELT3.2 Conductor Selection and Calculations

Related Academic Standards

C1 Interpreting written material.

C2 Interpreting visual materials (maps, charts, graphs, tables, etc.).

C3 Listening, comprehending, and taking appropriate actions.

C4 Accessing, organizing, and evaluating information.

C5 Using written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.

C6 Communicating ideas and information effectively using various oral and written forms for a variety of audiences and purposes.

M2 Exploring patterns and functions.

M7 Applying mathematical methods, concepts, and properties to solve a variety of real-world problems.

S8 Applying concepts related to the scientific process and method to include safety procedures for classroom and laboratory; use and care of scientific equipment; interrelationships between science, technology, and society; and effective communication of scientific results in oral, written, and graphic form.

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21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

National Educational Technology Standards for Students

T1 Basic operations and concepts
T3 Technology productivity tools
T4 Technology communications tools
T5 Technology research tools
T6 Technology problem-solving and decision-making tools

SUGGESTED REFERENCES


**Course Name:**

**ELT 1263 Blueprint Reading/Planning in Residential Installation**

**Course Abbreviation:** ELT 1263

**Classification:** Vocational–Technical Core (Certificate) or Vocational–Technical Elective (Associate Degree)

**Description:** Architectural symbols and electric symbols needed to read blueprints. All elevations and various plans associated with electrical wiring will be studied. Blank blueprints will be provided, and a list of all appliances and their amperage will be supplied. The blanks will be filled with receptacles, switches, and lighting outlets as required by NEC. Circuit layouts for all switching will be demonstrated. All branch circuits will be plotted on the blueprint. (3 sch: 2-hr lecture, 2-hr lab)

**Pre/Corequisites:** Fundamentals of Electricity (ELT 1192-3) or by permission of instructor

**Competencies and Suggested Objectives**

1. Explain ANSI symbols used in blueprint reading.
   a. List and explain symbols used for circuits.
   b. List and explain symbols used for lights, switches, appliances, and special connectors.
2. Explain plans and elevations critical to blueprint reading.
   a. List the various plans.
   b. Name the principal elevations.
   c. Draw a basic floor plan.
   d. Draw the four principal elevations.

3. Determine service entrance locations and heights.
   a. Determine proper heights to install wall bracket lights and weatherproof GFCI outlets.
   b. Determine finished grade and exterior structure finish.

4. Locate vertical wall receptacles, switches, and lighting outlets.
   a. Sketch the location of all receptacles.
   b. Sketch the location of all lights and switches.
   c. Sketch the location of all special outlets.

5. Prepare blueprints to meet NEC minimum requirements.
   a. Locate all receptacles, switches, and lighting outlets in each room.
   b. Determine the wiring circuits for all light switching.
   c. Lay out all appliance, multi-wire, individual, and general purpose branch circuits.

STANDARDS

National Center for Construction Education and Research Standards

ELT1.10 Basic Electrical Construction Drawings
Related Academic Standards

C1 Interpret written material.

C2 Interpret visual materials (maps, charts, graphs, tables, etc.).

C3 Listen, comprehend, and take appropriate actions.

C4 Access, organize, and evaluate information.

C5 Use written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.

C6 Communicate ideas and information effectively using various oral and written forms for a variety of audiences and purposes.

M4 Explore the concepts of measurement.

M7 Apply mathematical methods, concepts, and properties to solve a variety of real-world problems.

S8 Apply concepts related to the scientific process and method to include safety procedures for classroom and laboratory; use and care of scientific equipment; interrelationships between science, technology, and society; and effective communication of scientific results in oral, written, and graphic form.

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21st Century Skills

CS1 Global Awareness

CS2 Financial, Economic, and Business Literacy

CS3 Civic Literacy

CS4 Information and Communication Skills

CS5 Thinking and Problem-Solving Skills

CS6 Interpersonal and Self-Directional Skills
National Educational Technology Standards for Students

T1 Basic operations and concepts
T3 Technology productivity tools
T4 Technology communications tools
T5 Technology research tools
T6 Technology problem-solving and decision-making tools

SUGGESTED REFERENCES


Course Name: Switching Circuits for Residential, Commercial, and Industrial Applications

Course Abbreviation: ELT-1273

Classification: Vocational–Technical Core

Description: Introduction to various methods by which single pole, 3-way, and 4-way switches are used in residential, commercial, and industrial installations. Also includes installation and operation of low voltage, remote control switching (3 sch: 2-hr lecture, 2-hr lab)

Pre/Corequisites: Fundamentals of Electricity (ELT-1192-3) or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Demonstrate various switching circuits.</td>
</tr>
<tr>
<td>a. Explain the mechanical and electrical operation of various switches using the different wiring arrangements.</td>
</tr>
<tr>
<td>b. Demonstrate the single pole switching arrangements with two-wire when the lighting outlet and switch are fed.</td>
</tr>
<tr>
<td>c. Demonstrate the various three-way and four-way switching circuits using two-wire or three-wire cable.</td>
</tr>
<tr>
<td>d. Demonstrate objectives 1a-1c using a conduit raceway.</td>
</tr>
<tr>
<td>2. Demonstrate low voltage remote and relay control wiring.</td>
</tr>
<tr>
<td>a. Demonstrate the procedure for installing the outlet mounting relay system.</td>
</tr>
<tr>
<td>b. Demonstrate the procedure for installing the gang mounted relay system. (The 24-V transformer will be mounted at the relay location.)</td>
</tr>
<tr>
<td>c. Demonstrate the procedure for installing the zone mounted relay system.</td>
</tr>
</tbody>
</table>
STANDARDS

**National Center for Construction Education and Research Standards**

ELT1.6 Device Boxes

ELT1.9 Conductors and Cables

ELT1.11 Residential Electric Services

ELT3.8 Commercial Services

**Related Academic Standards**

C1 Interpret written material.

C2 Interpret visual materials (maps, charts, graphs, tables, etc.).

C3 Listen, comprehend, and take appropriate actions.

C4 Access, organize, and evaluate information.

C5 Use written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.

C6 Communicate ideas and information effectively using various oral and written forms for a variety of audiences and purposes.

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**21st Century Skills**

CS1 Global Awareness

CS2 Financial, Economic, and Business Literacy

CS3 Civic Literacy

CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills

CS6 Interpersonal and Self-Directional Skills

National Educational Technology Standards for Students

T1 Basic operations and concepts
T3 Technology productivity tools
T4 Technology communications tools
T5 Technology research tools
T6 Technology problem-solving and decision-making tools

SUGGESTED REFERENCES


Course Name:

ELT 1273 Switching Circuits for Residential, Commercial, and Industrial Applications


### ELT 1283 Estimating the Cost of an Electrical Installation

**Course Abbreviation:** ELT 1283

**Classification:** Vocational–Technical Elective

**Description:** Cost of an electrical installation. Specifications set forth for a particular structure (3 sch: 2-hr lecture, 2-hr lab)

**Pre/Corequisites:** Fundamentals of Electricity (ELT 1192-3), Residential/Commercial Wiring (ELT 1113), or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Calculate the total projected cost of materials and labor by using the results of a time and motion study, actual cost of materials, and margin of profit.</td>
</tr>
<tr>
<td>a. Prepare a lighting fixture schedule for a structure by determining which circuits require specific lights for the individual rooms.</td>
</tr>
<tr>
<td>b. Prepare a branch circuit material schedule.</td>
</tr>
<tr>
<td>c. Prepare a labor unit schedule for an electrical installation.</td>
</tr>
<tr>
<td>d. Prepare an estimate of materials used in an installation.</td>
</tr>
<tr>
<td>2. Prepare a branch circuit schedule.</td>
</tr>
<tr>
<td>a. Determine which rooms are on a particular branch circuit.</td>
</tr>
<tr>
<td>b. Determine the number of lighting outlets that are on the particular branch circuit.</td>
</tr>
<tr>
<td>c. Determine the number of switch outlets that are on a particular branch circuit.</td>
</tr>
<tr>
<td>d. Determine the number of receptacle outlets that are on a particular branch circuit.</td>
</tr>
</tbody>
</table>

STANDARDS
National Center for Construction Education and Research Standards

ELT1.6—Device Boxes
ELT1.9—Conductors and Cables

Related Academic Standards

C1—Interpret written material.
C2—Interpret visual materials (maps, charts, graphs, tables, etc.).
C4—Access, organize, and evaluate information.
C5—Use written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.
C6—Communicate ideas and information effectively using various oral and written forms for a variety of audiences and purposes.
M7—Apply mathematical methods, concepts, and properties to solve a variety of real-world problems.

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21st Century Skills

CS1—Global Awareness
CS2—Financial, Economic, and Business Literacy
CS3—Civic Literacy
CS4—Information and Communication Skills
CS5—Thinking and Problem-Solving Skills
CS6——Interpersonal and Self-Directional Skills

National Educational Technology Standards for Students

T1——Basic operations and concepts
T3——Technology productivity tools
T4——Technology communications tools
T5——Technology research tools
T6——Technology problem-solving and decision-making tools

SUGGESTED REFERENCES


Course Name: **ELT 1313 Automated Manufacturing Controls for Electrical Technology**

Course Abbreviation: **ELT 1313**

Classification: Vocational–Technical Elective

Description: This course is designed to teach the students the integrated control systems found in automated systems. Emphasis will be placed on encoders, optical devices, servo motors, stepper motors, computerized numerical control (CNC), vision and sensing systems, lasers, programmatic controllers, solid state motor controls, and other similar devices. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisites: Motor Controls ELT1413, PLC's ELT 2613, Solid State Motor Controls ELT 2424, or by permission of instructor

### Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>Competency</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Demonstrate the ability to develop a robotics process utilized in the electrical industry.</td>
</tr>
<tr>
<td>a</td>
<td>Plan a process.</td>
</tr>
<tr>
<td>b</td>
<td>Design and lay out a process using a programmable logic control.</td>
</tr>
<tr>
<td>2</td>
<td>Demonstrate the ability to interface components of a robotics process and how they relate to the electrical industry.</td>
</tr>
<tr>
<td>a</td>
<td>Integrate communication links between PLC, computer, and robot.</td>
</tr>
<tr>
<td>b</td>
<td>Integrate and maintain interlock of sequential operations using PLC and control wiring.</td>
</tr>
<tr>
<td>c</td>
<td>Utilize contact and noncontact sensors.</td>
</tr>
<tr>
<td>d</td>
<td>Integrate peripheral equipment into the process.</td>
</tr>
<tr>
<td>3</td>
<td>Demonstrate the ability to evaluate and troubleshoot a robotics process.</td>
</tr>
<tr>
<td>a</td>
<td>Evaluate system performance.</td>
</tr>
</tbody>
</table>
b. Apply problem-solving logic.

c. Read and interpret schematics.

d. Explain and operate basic test equipment.

STANDARDS

National Center for Construction Education and Research Standards

ELT3.11 Motor Controls

ELT4.7 Advanced Controls

ELT4.10 Motor Operation and Maintenance

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)

R2 Words in Context (same and opposite meaning)

R3 Recall Information (details, sequence)

R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause–effect)

R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)

M1 Addition of Whole Numbers (no regrouping, regrouping)

M2 Subtraction of Whole Numbers (no regrouping, regrouping)

M3 Multiplication of Whole Numbers (no regrouping, regrouping)

M4 Division of Whole Numbers (no remainder, remainder)

M5 Decimals (addition, subtraction, multiplication, division)

M6 Fractions (addition, subtraction, multiplication, division)

M7 Integers (addition, subtraction, multiplication, division)
21st Century Skills

CS1——Global Awareness

CS2——Financial, Economic, and Business Literacy

CS3——Civic Literacy

CS4——Information and Communication Skills

CS5——Thinking and Problem-Solving Skills

CS6——Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES


Course Name: ELT 1324 Calibration and Measurement Principles Used in the Electrical Industry

Course Abbreviation: ELT 1324
Classification: Vocational–Technical Elective

Description: This course introduces the students to various terms related to measurement principles and calibration techniques used in the electrical industry. With PLCs, the topic also includes the procedures and calibration of various instruments and PLCs used in industry. (4 sch: 3-hr lecture, 2-hr lab)

Prerequisites: Programmable Logic Controls ELT 2613 and Advanced Programmable Controls ELT 2623

Competencies and Suggested Objectives

1. Define terms associated with measurement and calibration procedures used in the electrical industry.
   a. Describe traceability of a standard.
   b. Describe and explain static and dynamic characteristics of an instrument.
   c. Explain elevated and suppressed zero.
   d. Discuss instrument drift.
   e. Discuss units of measurement pertaining to instrumentation.

2. Describe a standard calibration procedure used in the electrical industry.
   a. Develop a generic calibration procedure.
   b. Perform a calibration procedure on different instrumentation apparatus.
   c. Calibrate a PLC for installation.

   a. Perform basic operations of statistics.
   b. Explain statistics and the relationship to process control instrumentation.
STANDARDS

National Center for Construction Education and Research

INS2.4 Process Control Theory
INS2.5 Detectors, Secondary Elements, Transducers, and Transmitters
INS2.6 Controllers, Recorders, and Indicators
INS2.7 Control Valves, Actuators, and Positioners
INS2.12 Panel-Mounted Instruments
INS2.13 Installing Field-Mounted Instruments
INS2.14 Raceways for Instrumentation

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause–effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
A5 Measurement (money, time, temperature, length, area, volume)

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21st Century Skills

CS1——Global Awareness
CS2——Financial, Economic, and Business Literacy
CS3——Civic Literacy
CS4——Information and Communication Skills
CS5——Thinking and Problem-Solving Skills
CS6——Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES


Course Name:

**ELT 1334 Flexible Manufacturing Systems for Electrical Technology**

Course Abbreviation: ELT-1334

Classification: Vocational–Technical Elective

Description: This course is a production project that requires the student to apply technical skills acquired in previous courses. Project management is provided by the instructor with the students working as teams in each particular area of the manufacturing system. The students are required to plan the project and prepare the integrated system to manufacture a product. This includes all software, hardware, fixtures, clamping mechanisms, material handling requirements, sensors and interfacing, and external control devices. (4 sch: 2-hr lecture, 4-hr lab)

Prerequisites: Consent of instructor, Motor Controller ELT 1413, Advanced PLCs, ELT 2623, or Solid State Motor Controller ELT 2424

Competencies and Suggested Objectives

1. Plan a project that will utilize the automated system used in the electrical industry.
   a. Develop documentation that outlines major steps in the program.
   b. Develop a process flowchart that identifies and sequences primary production steps.

2. Plan and specify the automation equipment required for the electrical project.
   a. Identify the automation equipment required to support the project.
   b. Identify and list the individual process steps with supporting addresses and control data.
   c. Identify the material requirements.

3. Develop and program the project.
   a. Develop the initialization programming logic.
b. Develop the input/output logic.

c. Develop the process control logic.

4. Test and debug the project.
   a. Configure the automation system for the project.
   b. Troubleshoot and correct the program syntax and logic problems.

STANDARDS

National Center for Construction Education and Research Standards

ELT3.11 Motor Controls

ELT4.7 Advanced Controls

IMM3.4 Motor Controls

Related Academic Standards

R1 — Interpret Graphic Information (forms, maps, reference sources)
R2 — Words in Context (same and opposite meaning)
R3 — Recall Information (details, sequence)
R4 — Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause–effect)
R5 — Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 — Addition of Whole Numbers (no regrouping, regrouping)
M2 — Subtraction of Whole Numbers (no regrouping, regrouping)
M3 — Multiplication of Whole Numbers (no regrouping, regrouping)
T1 - Basic operations and concepts
T2 - Social, ethical, and human issues
T3 - Technology productivity tools
T6 - Technology problem-solving and decision-making tools

SUGGESTED REFERENCES


Course Name: **ELT 1343** Fundamentals of Instrumentation

Course Abbreviation: **ELT 1343**

Classification: Vocational–Technical Elective

Description: This course provides students with a general knowledge of instrumentation principles as they relate to the electrical industry. This course includes instruction in the basis of hydraulics and pneumatics and the use of electrical circuits in the instrumentation process. (3 sch: 2-hr lecture, 2-hr lab)
**Prerequisites:** Fundamentals of Electricity ELT 1192, AC and DC Circuits ELT 1144

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Demonstrate a working knowledge of instrumentation as it pertains to the electrical industry.</td>
</tr>
<tr>
<td>a. Define terms associated with instrumentation.</td>
</tr>
<tr>
<td>b. Discuss basic theory of hydraulics, pneumatics, and electromagnetic controls.</td>
</tr>
<tr>
<td>c. Identify basic symbols used with hydraulics, pneumatics, and electromagnetic systems.</td>
</tr>
<tr>
<td>2. Identify the type of instrumentation input and output devices, and describe their applications.</td>
</tr>
<tr>
<td>a. Describe control elements for pressure, flow, temperature, and level.</td>
</tr>
<tr>
<td>b. Identify the types of input and output devices.</td>
</tr>
<tr>
<td>c. Describe the input and output devices.</td>
</tr>
<tr>
<td>3. Identify the types of electrical signals used in instrumentation.</td>
</tr>
<tr>
<td>a. Describe the transmission of information to include current, pressure, and frequency.</td>
</tr>
<tr>
<td>b. Explain the principles of the transmission information input and output.</td>
</tr>
<tr>
<td>4. Describe fundamentals of electrical and electronic process controls.</td>
</tr>
<tr>
<td>a. Label a block diagram of an open loop system and a closed loop system.</td>
</tr>
<tr>
<td>b. Describe characteristics of an open loop and a closed loop system.</td>
</tr>
<tr>
<td>5. Design a preventive maintenance program for instrumentation systems.</td>
</tr>
<tr>
<td>a. Describe the techniques and procedures for troubleshooting, calibrating, and repairing an instrumentation system.</td>
</tr>
<tr>
<td>b. Demonstrate the ability to sketch a piping and instrument drawing.</td>
</tr>
</tbody>
</table>
National Center for Construction Education and Research Standards

INS1.1 Hand Tools for Instrumentation
INS1.3 Power Tools for Instrumentation
INS1.4 Electrical Systems for Instrumentation
INS1.7 Instrumentation Drawings and Documents, Part One
INS1.10 Flow, Pressure, Level, and Temperature

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause–effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
A1 Numeration (ordering, place value, scientific notation)
A6 Geometry (angles, Pythagorean theory)
A8 Estimation (rounding, estimation)
21st Century Skills

CS2—Financial, Economic, and Business Literacy

CS5—Thinking and Problem-Solving Skills

SUGGESTED REFERENCES


Course Name:

ELT 1334 Flexible Manufacturing Systems for Electrical Technology


ELT 1353 Fundamentals of Robotics for Electrical Technology
**Course Abbreviation:** ELT 1353

**Classification:** Vocational–Technical Elective

**Description:** This course is designed to introduce the student to industrial robots. Topics to be covered include robotics history, industrial robot configurations, operation, and basic programming and how they relate to the electrical industry. (3 sch: 2- hr lecture, 2- hr lab)

**Pre/Corequisites:** Fundamentals of Electricity ELT 1192, Motor Controls ELT 1413, PLCs ELT 2613, Solid State Motor Control ELT 2424, Automated Manufacturing Controls for Electrical Technology

**Competencies and Suggested Objectives**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Describe the various major components of all robots.</td>
</tr>
<tr>
<td></td>
<td>a. Explain the axes of movement.</td>
</tr>
<tr>
<td></td>
<td>b. Label each major component.</td>
</tr>
<tr>
<td></td>
<td>c. Identify four general types of work envelopes.</td>
</tr>
<tr>
<td></td>
<td>d. Discuss three general forms of robot actuation.</td>
</tr>
<tr>
<td></td>
<td>e. Identify different types of input devices used with robot controllers.</td>
</tr>
<tr>
<td></td>
<td>f. Describe the characteristics of a robot that distinguish it from other types of automated machinery.</td>
</tr>
</tbody>
</table>

| 2. | Demonstrate safety procedures used in the automated environment. |
|   | a. Apply safety rules for personal and general shop safety including eye, ear, and body protection; general rules of shop conduct; and the use of safety color coding. |
|   | b. Apply general safety rules for tool and equipment use including hand tools, air and electric power tools, and other shop equipment. |
|   | c. Apply general safety rules associated with working on various robotics systems. |
|   | d. Apply rules and procedures associated with fire safety including procedures for handling and storing flammable liquids and proper use of fire fighting devices. |
3. Demonstrate the ability to operate robots.
   a. Evaluate robot performance.
   b. Apply basic programming skills.
   c. Identify and discuss end effectors.
   d. Identify and discuss visual and tactile sensors.
   e. Demonstrate basic troubleshooting techniques.

STANDARDS

National Center for Construction Education and Research Standards

EST2.10 Computer Applications

EST3.7 Maintenance and Repair

INS1.1 Hand Tools for Instrumentation

INS1.2 Electrical Safety

INS1.3 Power Tools for Instrumentation

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)

R2 Words in Context (same and opposite meaning)

R3 Recall Information (details, sequence)

R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause–effect)

R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)

M1 Addition of Whole Numbers (no regrouping, regrouping)
M2—Subtraction of Whole Numbers (no regrouping, regrouping)
M3—Multiplication of Whole Numbers (no regrouping, regrouping)
M4—Division of Whole Numbers (no remainder, remainder)
M5—Decimals (addition, subtraction, multiplication, division)
M6—Fractions (addition, subtraction, multiplication, division)
M7—Integers (addition, subtraction, multiplication, division)
M8—Percents
M9—Algebraic Operations

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21st Century Skills

CS1—Global Awareness
CS2—Financial, Economic, and Business Literacy
CS3—Civic Literacy
CS4—Information and Communication Skills
CS5—Thinking and Problem-Solving Skills
CS6—Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES


Course Name: **ELT 1363 Industrial Hydraulics for Electrical Technology**

Course Abbreviation: **ELT-1363**

Classification: Vocational–Technical Elective

Description: This course introduces the students to basic hydraulics, hydraulic actuators, accumulators, valves, pumps, motors, fluids, coolers, and filters. Emphasis is placed on development of hydraulic control circuits, electrical interfacing techniques, and troubleshooting. (3 sch: 2- hr lecture, 2-hr lab)

Pre/Corequisites: Fundamentals ELT 1193, Motor Controls ELT 1413, PLCs ELT 2613

**Competencies and Suggested Objectives**

1. Define and describe basic laws governing liquids.
   a. Describe the concept of force, flow, and pressure.
   b. Analyze the relationship of force and pressure of a circuit.
   c. Explain what causes flow in a circuit.
   d. Calculate area, pressure, velocity, and rate of flow.
   e. Explain and apply Pascal’s law in hydraulics.

2. Identify and draw symbols for hydraulics used in the electrical industry.
   a. Explain the logic for drawing symbols for hydraulic components.
   b. Draw individual hydraulic components.
<table>
<thead>
<tr>
<th>3. Describe operation and nomenclature of various pumps.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Analyze the operation of vane, gear, and piston pumps.</td>
</tr>
<tr>
<td>b. Describe the operation of centrifugal pumps.</td>
</tr>
<tr>
<td>4. Explain liquids as pertaining to the transmission of energy.</td>
</tr>
<tr>
<td>a. Describe various types of hydraulic fluid.</td>
</tr>
<tr>
<td>b. Explain the purpose of the fluid reservoir, filtration system, and the heat exchange in hydraulics.</td>
</tr>
<tr>
<td>c. Illustrate the relationship of viscosity, temperature, and resistance.</td>
</tr>
<tr>
<td>5. Describe the operation of flow, pressure, and directional control valves.</td>
</tr>
<tr>
<td>a. Explain basic design features used in each type of control valve.</td>
</tr>
<tr>
<td>b. Demonstrate how flow, pressure, and directional valves are used.</td>
</tr>
<tr>
<td>6. Explain the types of actuators used in hydraulics.</td>
</tr>
<tr>
<td>a. List important cylinder design features.</td>
</tr>
<tr>
<td>b. Explain basic design features of hydraulic motors and other rotary actuators.</td>
</tr>
<tr>
<td>7. Explain, construct, and troubleshoot various hydraulic applications in the electrical industry.</td>
</tr>
<tr>
<td>a. Explain the purpose of a sequence circuit.</td>
</tr>
<tr>
<td>b. Construct and troubleshoot a sequence circuit.</td>
</tr>
<tr>
<td>c. Explain the purpose of a counterbalance circuit.</td>
</tr>
<tr>
<td>d. Construct and troubleshoot a counterbalance circuit.</td>
</tr>
<tr>
<td>8. Interface electrical and hydraulic circuits.</td>
</tr>
<tr>
<td>a. Wire an electrical control circuit.</td>
</tr>
<tr>
<td>b. Interface a hydraulic circuit with ladder logic.</td>
</tr>
<tr>
<td>c. Interface a hydraulic circuit with PLCs.</td>
</tr>
</tbody>
</table>

STANDARDS
National Center for Construction Education and Research Standards

IMM3.12 Hydraulic and Pneumatic Controls

Related Academic Standards

R1—Interpret Graphic Information (forms, maps, reference sources)
R2—Words in Context (same and opposite meaning)
R3—Recall Information (details, sequence)
R4—Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause–effect)
R5—Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1—Addition of Whole Numbers (no regrouping, regrouping)
M2—Subtraction of Whole Numbers (no regrouping, regrouping)
M3—Multiplication of Whole Numbers (no regrouping, regrouping)
M4—Division of Whole Numbers (no remainder, remainder)
M5—Decimals (addition, subtraction, multiplication, division)
M6—Fractions (addition, subtraction, multiplication, division)
M7—Integers (addition, subtraction, multiplication, division)
M8—Percents
M9—Algebraic Operations

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21st Century Skills

CS1—Global Awareness
CS2——Financial, Economic, and Business Literacy
CS3——Civic Literacy
CS4——Information and Communication Skills
CS5——Thinking and Problem-Solving Skills
CS6——Interpersonal and Self-Directional Skills

**SUGGESTED REFERENCES**


**Course Name:** ELT 1373 *Industrial Pneumatics for Electrical Technology*

**Course Abbreviation:** ELT-1373

**Classification:** Vocational–Technical Elective
**Description:** This course introduces the students to basic pneumatic principles, compression of air, work devices, control devices, and circuit diagrams. Emphasis is placed on development of pneumatic control circuits, electromechanical control of fluid power, and troubleshooting techniques. (3 sch: 2-hr lecture, 2-hr lab)

**Prerequisites:** Fundamentals of Electricity ELT 1192, Motor Controls ELT 1413, PLCs ELT 2613

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Define and describe basic laws governing gases.</td>
</tr>
<tr>
<td>a. Describe the concept of force, flow, and pressure.</td>
</tr>
<tr>
<td>b. Analyze the relationship of force and pressure on a circuit.</td>
</tr>
<tr>
<td>c. Explain what causes flow in a circuit.</td>
</tr>
<tr>
<td>d. Calculate area, pressure, velocity, and rate of flow.</td>
</tr>
<tr>
<td>e. Explain and apply Charles’ law in pneumatics.</td>
</tr>
<tr>
<td>f. Explain and verify Boyle’s law in a circuit.</td>
</tr>
<tr>
<td>2. Identify and draw symbols for pneumatics used in the electrical industry.</td>
</tr>
<tr>
<td>a. Explain the logic for drawing symbols for pneumatic components.</td>
</tr>
<tr>
<td>b. Draw individual pneumatic components.</td>
</tr>
<tr>
<td>3. Describe the operation and nomenclature of various compressors.</td>
</tr>
<tr>
<td>a. Analyze the operation of vane and piston pumps in pneumatics.</td>
</tr>
<tr>
<td>b. Analyze the operation of air compressors.</td>
</tr>
<tr>
<td>4. Explain fluids as pertaining to the transmission of energy.</td>
</tr>
<tr>
<td>a. Explain the purpose of the receiver tanks, filtration system, and heat exchanger.</td>
</tr>
<tr>
<td>b. Describe the purpose of pressure drops in pneumatic systems.</td>
</tr>
<tr>
<td>5. Describe the operation of flow, pressure, and directional control valves.</td>
</tr>
<tr>
<td>a. Explain basic design features used in each type of control valve.</td>
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<tr>
<td>6.</td>
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<td>a.</td>
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<td>b.</td>
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<td>c.</td>
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<td>7.</td>
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<tr>
<td>a.</td>
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<tr>
<td>b.</td>
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<tr>
<td>8.</td>
</tr>
<tr>
<td>a.</td>
</tr>
<tr>
<td>b.</td>
</tr>
</tbody>
</table>

**STANDARDS**

**National Center for Construction Education and Research Standards**

**IMM3.12 Hydraulic and Pneumatic Controls**

**Related Academic Standards**

- R1—Interpret Graphic Information (forms, maps, reference sources)
- R2—Words in Context (same and opposite meaning)
- R3—Recall Information (details, sequence)
- R4—Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause–effect)
- R5—Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
- M1—Addition of Whole Numbers (no regrouping, regrouping)
M2—Subtraction of Whole Numbers (no regrouping, regrouping)
M3—Multiplication of Whole Numbers (no regrouping, regrouping)
M4—Division of Whole Numbers (no remainder, remainder)
M5—Decimals (addition, subtraction, multiplication, division)
M6—Fractions (addition, subtraction, multiplication, division)
M7—Integers (addition, subtraction, multiplication, division)
M8—Percents
M9—Algebraic Operations

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21st-Century Skills

CS1—Global Awareness
CS2—Financial, Economic, and Business Literacy
CS3—Civic Literacy
CS4—Information and Communication Skills
CS5—Thinking and Problem-Solving Skills
CS6—Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES


Course Name: **ELT 1383** Industrial Robotics for Electrical Technology

Course Abbreviation: ELT-1383

Classification: Vocational–Technical Elective

Description: This course teaches the operating systems and advanced programming methods of industrial robots. Actual industrial grade robots are used to train the student in the areas of operation, maintenance, troubleshooting, service procedures, and robotics applications. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Robotics

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Demonstrate the ability to integrate a robot into a process affiliated to the electrical industry.</strong></td>
</tr>
<tr>
<td>a. Write programs on industrial robots to perform simulated industrial processes to operate within the confines of each robot’s work envelope.</td>
</tr>
<tr>
<td>b. Demonstrate the improvement of the efficiency of an automated robotics process by reducing cycle time, decreasing memory usage, using advanced programming techniques, and so forth.</td>
</tr>
<tr>
<td><strong>2. Demonstrate the ability to integrate peripheral equipment.</strong></td>
</tr>
<tr>
<td>a. Program and interface peripheral devices such as a programmable logic controller into robotics work cells.</td>
</tr>
<tr>
<td>b. Interface contact and noncontact sensors into robotics work cell.</td>
</tr>
</tbody>
</table>
3. Demonstrate the ability to troubleshoot and maintain a robotics work cell.
   a. Locate and isolate faults in robotics applications.
   b. Demonstrate the use of test equipment and troubleshooting logic to repair faults.
   c. Perform routine maintenance procedures on robots with the use of checklists and service equipment (null servo valves, zero encoders, calibrate potentiometers, etc.).

STANDARDS

National Center for Construction Education and Research Standards

EST2.10 Computer Applications
EST3.7 Maintenance and Repair

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause–effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
Course Name: **ELT 1393** Servo Control Systems for Electrical Technology

Course Abbreviation: **ELT-1393**

SUGGESTED REFERENCES


**Classification:** Vocational–Technical Elective

**Description:** This course is designed to teach servo components; servo valves; velocity servos; positional servos; force, pressure, and torque servos; servo amplifiers; programmers; and servo analysis. Emphasis is placed on servo trim and maintenance and the applications of servo systems. (3 sch: 2-hr lecture, 2-hr lab)

**Prerequisite:** None

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### Competencies and Suggested Objectives

1. Identify and discuss the components and characteristics of a servo system used in the electrical industry.
   - a. Identify the components of a basic electrohydraulic servo system.
   - b. Identify servo valves as to control type and construction.
   - c. Demonstrate operating characteristics of a servo valve by conducting performance tests.
   - d. Explain servo valve construction, operation, and function.
   - e. Identify the types of pilot stages for servo valves.
   - f. Mechanically and/or electrically null a servo valve.
   - g. Test a servo valve for flow gain, saturation, and linearity.
   - h. Test a servo valve for pressure gain.

2. Demonstrate the ability to construct and analyze open loop and closed loop systems.
   - a. Draw a block diagram of a closed loop servo system.
   - b. Identify and explain five control modes of a closed loop servo system.
   - c. List and describe transducers commonly used with angular, linear, and velocity control systems.
   - d. Construct and analyze open loop and closed loop velocity control systems.
   - e. Construct and analyze open loop and closed loop angular position control systems.
f. Construct and analyze open loop and closed loop linear position control systems.

g. Demonstrate the concepts of accuracy, error, gain, response, and stability of closed loop servo systems.

3. Demonstrate the ability to troubleshoot and repair a servo control system used in the electrical industry.

   a. Apply troubleshooting logic to solve electrical problems with a servo control system.

   b. Apply troubleshooting logic to locate and repair a fault in the hydraulic section of an electrohydraulic servo control system.

   c. Construct and demonstrate an angular position control system as it relates to a simulated machine function.

   d. Construct and demonstrate velocity control as it relates to a simulated machine function.

   e. Construct and demonstrate linear position control as it relates to a simulated machine function.

STANDARDS

National Center for Construction Education and Research Standards

ELT4.7—Advanced Controls

Related Academic Standards

R1—Interpret Graphic Information (forms, maps, reference sources)

R2—Words in Context (same and opposite meaning)

R3—Recall Information (details, sequence)

R4—Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause–effect)

R5—Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)

M1—Addition of Whole Numbers (no regrouping, regrouping)
M2—Subtraction of Whole Numbers (no regrouping, regrouping)

M3—Multiplication of Whole Numbers (no regrouping, regrouping)

M4—Division of Whole Numbers (no remainder, remainder)

M5—Decimals (addition, subtraction, multiplication, division)

M6—Fractions (addition, subtraction, multiplication, division)

M7—Integers (addition, subtraction, multiplication, division)

M8—Percents

M9—Algebraic Operations

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21st Century Skills

CS1—Global Awareness

CS2—Financial, Economic, and Business Literacy

CS3—Civic Literacy

CS4—Information and Communication Skills

CS5—Thinking and Problem-Solving Skills

CS6—Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES


Course Name: **ELT 1413 Motor Control Systems**

Course Abbreviation: **ELT 1413**

Classification: Vocational–Technical Core

Description: Installation of different motor control circuits and devices. Emphasis is placed on developing the student's ability to diagram, wire, and troubleshoot the different circuits and mechanical control devices. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisites: Fundamentals of Electricity (ELT 1192-3) or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Install different control circuits and devices.</td>
</tr>
<tr>
<td>a. Diagram and wire a two-wire and three-wire motor control circuit with indicating pilot lights.</td>
</tr>
<tr>
<td>b. Diagram, wire, and troubleshoot an on-delay and off-delay timer circuit.</td>
</tr>
<tr>
<td>c. Diagram and wire multi-control manual station.</td>
</tr>
<tr>
<td>d. Diagram and wire a “hands-off-automatic” control station.</td>
</tr>
<tr>
<td>e. Diagram and wire a jog-forward/jog-reverse control.</td>
</tr>
<tr>
<td>2. Troubleshoot different control circuits and devices.</td>
</tr>
<tr>
<td>a. Troubleshoot a two-wire and three-wire motor control circuit with indicating pilot lights.</td>
</tr>
</tbody>
</table>
b. Troubleshoot an on-delay and off-delay timer circuit.

c. Troubleshoot a multi-control manual station.

d. Troubleshoot a “hands-off-automatic” control station.

e. Troubleshoot a jog-forward/jog-reverse control.

STANDARDS

National Center for Construction Education and Research Standards

ELT3.9 Motor Calculations

ELT3.11 Motor Controls

Related Academic Standards

C2 Interpret visual materials (maps, charts, graphs, tables, etc.).

C4 Access, organize, and evaluate information.

C5 Use written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.

C6 Communicate ideas and information effectively using various oral and written forms for a variety of audiences and purposes.

M2 Explore patterns and functions.

M7 Apply mathematical methods, concepts, and properties to solve a variety of real-world problems.

S8 Apply concepts related to the scientific process and method to include safety procedures for classroom and laboratory; use and care of scientific equipment; interrelationships between science, technology, and society; and effective communication of scientific results in oral, written, and graphic form.

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21st Century Skills

CS1——Global Awareness
CS2——Financial, Economic, and Business Literacy
CS3——Civic Literacy
CS4——Information and Communication Skills
CS5——Thinking and Problem-Solving Skills
CS6——Interpersonal and Self-Directional Skills

National Educational Technology Standards for Students

T1——Basic operations and concepts
T3——Technology productivity tools
T4——Technology communications tools
T5——Technology research tools
T6——Technology problem-solving and decision-making tools

SUGGESTED REFERENCES

Course Name: **ELT 1434 Solid State Devices and Circuits for Electrical Technology**

Course Abbreviation: ELT-1434

Classification: Vocational–Technical Elective

Description: Active devices that include PN junction diodes, bipolar transistors, bipolar transistor circuits, and unipolar devices with emphasis on low frequency application and troubleshooting. (4 sch: 2-hr lecture, 4-hr lab)

Prerequisite: DC Circuits (EET 1114)

### Competencies and Suggested Objectives

1. Explain the characteristics of semiconductor materials and theory of operation of PN junctions.
   
   a. Explain basic atomic structure.
   
   b. Define intrinsic, P-type, and N-type.
   
   c. Analyze an unbiased PN junction.
2. Explain semiconductor diode theory, and apply to diode circuits.
   a. Describe the characteristics of a diode.
   b. Analyze and demonstrate half wave rectifier circuit.
   c. Analyze and demonstrate full wave rectifier circuit.
   d. Analyze and demonstrate bridge rectifier circuit.

3. Analyze the operation of semiconductor special purpose diodes.
   a. Analyze and demonstrate the operation of zener diode circuit.
   b. Analyze and demonstrate the operation of light emitting diode circuit.
   c. Explain the characteristics of Schottkey diodes.
   d. Explain the characteristics of varactor diodes.

4. Analyze the operation of bipolar junction transistors.
   a. Define and identify transistor voltages and currents.
   b. Analyze and demonstrate the operation of a DC common emitter circuit.
   c. Demonstrate the use of collector curves.
   d. Demonstrate the use of load lines.
   e. Explain and demonstrate base, emitter, and voltage divider biasing.

5. Explain and analyze the construction of BJT amplifiers.
   a. Analyze and discuss the basic operation of a common emitter voltage amplifier.
   b. Given a common emitter amplifier circuit, draw the AC equivalent circuit, and solve for \( V_{in}, V_{out}, \) and \( A \).
   c. Explain how the swamped common emitter amplifier works, and discuss its advantages.
   d. Given a swamped common emitter amplifier circuit, draw the AC equivalent circuit, and solve for \( Z_{in}, V_{in}, V_{out}, A \).
   e. Construct common emitter amplifier, and compare measured parameters to calculated
f. Given a cascaded common emitter amplifier, calculate gain of stage one, gain of stage two, and output voltage.

g. Given a power amplifier circuit, solve for the maximum generator voltage that will produce an unclipped output signal, and solve the maximum efficiency of the amplifier.

h. Given a emitter-follower circuit, solve for $Z_{in}$, $V_{in}$, $A$, and $V_{out}$.

i. Describe the characteristics of a class A power amplifier to include the factors that limit the power rating of a transistor.

j. Construct class A and class B amplifiers and troubleshoot the circuits.

6. Analyze the operation of field effect transistors, and demonstrate their applications.

   a. Describe the basic construction of a JFET.

   b. Calculate the proportional pinch off voltage, and determine the operating area of a JFET.

   c. Given a JFET circuit, and determine $I_D$ and $V_{ds}$.

   d. Given a JFET amplifier circuit, draw the AC equivalent circuit and solve for $g_{mo}$, $g_m$, $Z_{in}$, $V_{in}$, $A$, and $V_{out}$.

   e. Given a JFET source follower circuit with a given $g_m$, solve for $V_{in}$, $A$, and $V_{out}$.

   f. Illustrate the construction of and describe the operation of the depletion-mode and the enhancement-mode MOSFET.

   g. Analyze other FET applications such as multiplying, switching, chopper, AGC, and sample and hold amplifier.

7. Analyze the operation of thyristors, and demonstrate their applications.

   a. Describe the four-layer diode, and discuss how it is turned on and off.

   b. Describe how the SCR operates in different applications.

   c. Construct a latching SCR with a varying input voltage, and determine when the output voltage is latched.

   d. Describe the main characteristics of the variations of the SCR, and discuss the difference in device symbols.
e. Describe the characteristics of the diac and triac.

f. Calculate the intrinsic standoff voltage for a unijunction transistor (UJT), and state how it works.

g. Analyze thyristor applications such as over voltage detector, sawtooth generator, SCR crowbar, and controlled SCR circuits phase angle controlled circuits.

h. Construct thyristor circuits, and vary the latching parameters; measure the output to view switching and control of the device.

STANDARDS

National Center for Construction Education and Research Standards

ELT4.7 Advanced Controls

Related Academic Standards

C1——Interpret written material.

C2——Interpret visual materials (maps, charts, graphs, tables, etc.).

C4——Access, organize, and evaluate information.

C5——Use written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.

C6——Communicate ideas and information effectively using various oral and written forms for a variety of audiences and purposes.

M1——Relate number relationships, number systems, and number theory.

M3——Explore algebraic concepts and processes.

21st Century Skills
**National Educational Technology Standards for Students**

T1 — Basic operations and concepts
T2 — Social, ethical, and human issues
T3 — Technology productivity tools
T6 — Technology problem-solving and decision-making tools

**Suggested References**


**Course Name:**

**ELT 1513 Data Acquisition and Communications**

**Course Abbreviation:** ELT 1513
**Classification:** Vocational–Technical Elective

**Description:** This is a course in acquisition and communication of systems data in industrial automated applications. (3 sch: 2-hr lecture, 2-hr lab)

**Prerequisite:** Consent of instructor

### Competencies and Suggested Objectives

1. Explain data communication components used in automatic systems.
   - a. Identify characteristics and uses of various EIA standard data communication interfaces.
   - b. Describe standard serial communications used in computers.
   - c. Describe parallel communication interfaces.
   - d. Explain Ethernet.
   - e. Explain Controlnet.

2. Use data communication software PLC and a computer to connect a network.
   - a. Configure a computer for serial or parallel communications.
   - b. Perform data transfers between computers.
   - c. Use communication test equipment to troubleshoot communications links.

3. Use computers and/or controllers for data acquisition.
   - a. Interface sensors with computer or controller for data acquisition using Ethernet.
   - b. Configure software and computer for data acquisition from a PLC.

**STANDARDS**

*National Center for Construction Education and Research*
ELT3.10 Voice, Data, and Video

ELT3.11 Motor Controls

ELT4.7 Advanced Controls

Related Academic Standards

R1—Interpret Graphic Information (forms, maps, reference sources)

R2—Words in Context (same and opposite meaning)

R3—Recall Information (details, sequence)

R4—Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause–effect)

R5—Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)

M1—Addition of Whole Numbers (no regrouping, regrouping)

M2—Subtraction of Whole Numbers (no regrouping, regrouping)

M3—Multiplication of Whole Numbers (no regrouping, regrouping)

M4—Division of Whole Numbers (no remainder, remainder)

M5—Decimals (addition, subtraction, multiplication, division)

M6—Fractions (addition, subtraction, multiplication, division)

M7—Integers (addition, subtraction, multiplication, division)

M8—Percents

M9—Algebraic Operations

L1—Usage (pronoun, tense, subject–verb agreement, adjective, adverb)

L2—Sentence Formation (fragments, run-on, clarity)

L3—Paragraph Development (topic sentence, supporting sentence, sequence)

L4—Capitalization (proper noun, titles)

L5—Punctuation (comma, semicolon)

L6—Writing Conventions (quotation marks, apostrophe, parts of a letter)
21st Century Skills

CS1  Global Awareness
CS2  Financial, Economic, and Business Literacy
CS3  Civic Literacy
CS4  Information and Communication Skills
CS5  Thinking and Problem-Solving Skills
CS6  Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES


Course Name: ELT 1523 Fundamentals of Fiber Optics for Electrical Technology

Course Abbreviation: ELT-1523

Classification: Vocational-Technical Elective
**Description:** Fiber-optic cable in modern industry applications (3 sch: 2-hr lecture, 2-hr lab)

**Pre/Corequisites:** Fundamentals of Electricity ELT 1192, AC/DC Circuits ELT 1144

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Demonstrate and practice general safety procedures in the school and work site environments.</td>
</tr>
<tr>
<td>a. Apply relevant and appropriate safety techniques.</td>
</tr>
<tr>
<td>b. Demonstrate an understanding of and comply with relevant OSHA safety standards.</td>
</tr>
<tr>
<td>2. Describe the history and advantages of fiber-optic systems and how they relate to the electrical industry.</td>
</tr>
<tr>
<td>a. Describe the limitations of wire communications systems.</td>
</tr>
<tr>
<td>b. List the advantages of optical fiber communications over electrical wire communications.</td>
</tr>
<tr>
<td>3. Explain the operation and application of optical signal sources.</td>
</tr>
<tr>
<td>a. Apply appropriate safety practices to optical signal sources.</td>
</tr>
<tr>
<td>b. Explain the advantages and disadvantages of LEDs as optical signal sources.</td>
</tr>
<tr>
<td>c. Explain the operation of modulator circuits for optical signal sources.</td>
</tr>
<tr>
<td>4. Explain the operation and application of fiber-optic system components.</td>
</tr>
<tr>
<td>a. Describe the construction of optical fibers.</td>
</tr>
<tr>
<td>b. Explain optical fiber cable specifications.</td>
</tr>
<tr>
<td>5. Describe properties of different types of optical fibers.</td>
</tr>
<tr>
<td>a. Differentiate between the properties and characteristics of plastic and glass optical fibers.</td>
</tr>
<tr>
<td>b. Describe the effect of core size on efficiency and bandwidth.</td>
</tr>
<tr>
<td>c. Describe fiber-optic cables available for indoor and outdoor installation.</td>
</tr>
<tr>
<td>d. Prepare and complete a splice of fiber-optic cable following industry standards and safety procedures.</td>
</tr>
<tr>
<td>e. Describe requirements for certification as a fiber-optic technician.</td>
</tr>
</tbody>
</table>
6. Explain the installation, connection, terminations, and maintenance of a fiber-optic system in residential and commercial applications.
   a. Show the proper installation of fiber-optic systems.
   b. Demonstrate the proper connections of fiber-optic systems.
   c. Demonstrate the proper terminations of fiber-optic systems.
   d. Show the proper maintenance of fiber-optic systems.

7. Demonstrate an understanding of how fiber optics are covered by the NEC.
   a. Explain protection of fiber-optic installation and terminations.
   b. Demonstrate proper installations of raceways and wiring methods for fiber-optic applications.

8. Demonstrate the proper methods for termination of fiber optics.
   a. List NEC references to fiber-optic installations.
   b. Demonstrate proper termination methods on various fiber-optic cables.

STANDARDS

National Center for Construction Education and Research Standards

ELT3.10 Voice, Data, and Video
EST1.8 Low-Voltage Cabling
EST2.8 Wire and Cable Terminations
EST2.9 Introduction to Codes and Standards
EST3.1 Cable Selection
EST3.3 Fiber Optics
**Related Academic Standards**

C1—— Interpret written material.

C2—— Interpret visual materials (maps, charts, graphs, tables, etc.).

C4—— Access, organize, and evaluate information.

C5—— Use written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.

C6—— Communicate ideas and information effectively using various oral and written forms for a variety of audiences and purposes.

S8—— Apply concepts related to the scientific process and method to include safety procedures for classroom and laboratory; use and care of scientific equipment; interrelationships between science, technology, and society; and effective communication of scientific results in oral, written, and graphic form.

**21st Century Skills**

CS1—— Global Awareness

CS2—— Financial, Economic, and Business Literacy

CS3—— Civic Literacy

CS4—— Information and Communication Skills

CS5—— Thinking and Problem-Solving Skills

CS6—— Interpersonal and Self-Directional Skills

**National Educational Technology Standards for Students**

T1—— Basic operations and concepts

T2—— Social, ethical, and human issues

T3—— Technology productivity tools
T5 — Technology research tools
T6 — Technology problem-solving and decision-making tools

STANDARDS


**Course Name:** ELT 1533 *Fundamentals of Data Communications for Electrical Technology*

**Course Abbreviation:** ELT 1533

**Classification:** Vocational–Technical Elective

**Description:** Concepts of telephony, local area networks, wide area networks, data transmission, and topology methods (3 sch: 2-hr lecture, 2-hr lab)

**Prerequisite:** None

**Competencies and Suggested Objectives**

1. Discuss basic communications and how they relate to the electrical industry in modern manufacturing plants.
   
   a. Analyze various communication procedures between a computer and PLC.
### 2. Analyze hardware, media, and software for use in data communication used between PLCs and computers in manufacturing plants.
- **a.** Discuss uses of modems.
- **b.** Describe various communications media.
- **c.** Describe data transmission codes and protocols.

### 3. Discuss communication networks and the installation of each.
- **a.** Discuss industrial network basics (Ethernet, Controlnet, and Devicenet).
- **b.** Analyze local area networks.
- **c.** Analyze wide area networks.
- **d.** Discuss planning, design, and implementation of networks.

### 4. Discuss the future of communication and the electrical industry within manufacturing plants.
- **a.** Analyze current trends and issues.
- **b.** Utilize teleconferencing/video conferencing techniques.

### 5. Demonstrate the use of the Internet.
- **a.** Explain what the Internet is.
- **b.** Use electronic mail on the Internet.
- **c.** Use gopher and the World Wide Web.
- **d.** Utilize browsers to scan the Internet.

### Standards

**National Center for Construction Education and Research Standards**

ELT3.10 Voice, Data, and Video
Related Academic Standards

C1——Interpret written material.
C2——Interpret visual materials (maps, charts, graphs, tables, etc.).
C3——Listen, comprehend, and take appropriate actions.
C4——Access, organize, and evaluate information.
C5——Use written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.
C6——Communicate ideas and information effectively using various oral and written forms for a variety of audiences and purposes.
M1——Relate number relationships, number systems, and number theory.
M2——Explore patterns and functions.
M6——Explore concepts of statistics and probability in real-world situations.
M7——Apply mathematical methods, concepts, and properties to solve a variety of real-world problems.
S8——Apply concepts related to the scientific process and method to include safety procedures for classroom and laboratory; use and care of scientific equipment; interrelationships between science, technology, and society; and effective communication of scientific results in oral, written, and graphic form.
21st Century Skills

CS1—Global Awareness
CS2—Financial, Economic, and Business Literacy
CS3—Civic Literacy
CS4—Information and Communication Skills
CS5—Thinking and Problem-Solving Skills
CS6—Interpersonal and Self-Directional Skills

National Educational Technology Standards for Students

T1—Basic operations and concepts
T2—Social, ethical, and human issues
T3—Technology productivity tools
T4—Technology communications tools
T5—Technology research tools
T6—Technology problem-solving and decision-making tools

STANDARDS


Course Name:

**ELT 1544** Network Systems for Electrical Technology

Course Abbreviations: ELT 1544
**Classification:** Vocational–Technical Elective

**Description:** Networking fundamentals, voice networking, LANs, and Internet. Also, upgrading of computers to support LAN technology (4 sch: 2-hr lecture, 4-hr lab)

**Pre/Corequisites:** Fundamentals of Electricity ELT 1192, AC\DC Circuits ELT 1144

**Competencies and Suggested Objectives**

1. Demonstrate and practice general safety procedures in the school and work site environments.
   - a. Apply relevant and appropriate safety techniques.
   - b. Demonstrate an understanding of and comply with relevant OSHA safety standards.

2. Discuss, describe, apply network fundamentals, and install network software used in the industrial manufacturing plants.
   - a. Discuss the history of telecommunication’s networking.
   - b. Discuss the handling and routing of calls.
   - c. Discuss and/or define standards and terminology.
   - d. Discuss network architectures and OSI.
   - e. Discuss, define, and relate analog and digital signals to networking.
   - f. Discuss, describe, and relate transmission media to networking.
   - g. Prepare both network hardware and software for computer installation to PLC operation.
   - h. Identify proper card slots for hardware installation.

3. Discuss internetworking devices.
   - a. Explain multiplexers.
   - b. Identify the uses of repeaters.
   - c. Examine the uses of PLC bridges and gateways.
d. Analyze the uses of hubs and switches.
e. Discuss wireless networking equipment.

4. Discuss and describe voice networks, and troubleshoot network communications interface.
   a. Discuss the public and private switching telephone network.
   b. Discuss and describe voice processing and call distribution.
   c. Discuss and describe T1 networks.
   d. Discuss and describe virtual networks.

5. Discuss, install, and troubleshoot LANs.
   a. Discuss and describe LANs.
   b. Discuss network software.
   c. Install LAN system, and verify for operation.
   d. Discuss and define network protocols.

6. Access the Internet.
   a. Discuss and interconnect with LANs.

STANDARDS

National Center for Construction Education and Research Standards

ELT3.11 Motor Controls
ELT4.7–Advanced Controls
EST3.9–Rack Systems
Related Academic Standards

C1 Interpret written material.
C2 Interpret visual materials (maps, charts, graphs, tables, etc.).
C3 Listen, comprehend, and take appropriate actions.
C4 Access, organize, and evaluate information.
C5 Use written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.
C6 Communicate ideas and information effectively using various oral and written forms for a variety of audiences and purposes.
M1 Relate number relationships, number systems, and number theory.
M7 Apply mathematical methods, concepts, and properties to solve a variety of real-world problems.
S6 Explore the principles and theories related to motion, mechanics, electricity, magnetism, light energy, thermal energy, wave energy, and nuclear physics.
S8 Apply concepts related to the scientific process and method to include safety procedures for classroom and laboratory; use and care of scientific equipment; interrelationships between science, technology, and society; and effective communication of scientific results in oral, written, and graphic form.

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills
National Educational Technology Standards for Students

T1 — Basic operations and concepts
T2 — Social, ethical, and human issues
T3 — Technology productivity tools
T5 — Technology research tools
T6 — Technology problem-solving and decision-making tools

STANDARDS


Course Name:

**ELT 1553** Satellite Systems

Course Abbreviation: **ELT-1553**

Classification: Vocational–Technical Elective

Description: Service, repair, and installation of residential and commercial satellite receiving systems and how they are used in the electrical industry (3 sch: 1-hr lecture, 4-hr lab)
**Prerequisites:** Fundamentals of Electricity ELT 1192, AC\DC Circuits ELT 1144

### Competencies and Suggested Objectives

1. Demonstrate and practice general safety procedures in the school and work site environments.
   a. Apply relevant and appropriate safety techniques.
   b. Demonstrate an understanding of and comply with relevant OSHA safety standards.

2. Identify and describe the basic principles and types of satellite systems.
   a. Describe the basic principles of satellite reception.
   b. Identify the types of satellite systems, and describe their differences and functions.

3. Install, align, and service satellite systems in commercial and residential locations.
   a. Determine best location, install, and align a satellite receiver for correct tracking.
   b. Troubleshoot and repair faulty components in a satellite receiver system.

4. Identify specific NEC references for the use of satellite systems.
   a. Look at the installation requirements for a satellite system.
   b. Develop a detailed material list, and estimate for the installation of specific satellite systems.

### STANDARDS

**National Center for Construction Education and Research Standards**

ELT3.10 Voice, Data, and Video

EST4.5 CCTV Systems

EST4.6 Broadband Systems
Related Academic Standards

C1 Interpret written material.
C2 Interpret visual materials (maps, charts, graphs, tables, etc.).
C3 Listen, comprehend, and take appropriate actions.
C4 Access, organize, and evaluate information.
C5 Use written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.
C6 Communicate ideas and information effectively using various oral and written forms for a variety of audiences and purposes.
S8 Apply concepts related to the scientific process and method to include safety procedures for classroom and laboratory; use and care of scientific equipment; interrelationships between science, technology, and society; and effective communication of scientific results in oral, written, and graphic form.
3C Install or maintain cables for a satellite system.
3D Terminate cables used in satellite systems.
3E Design and install raceways for satellite systems installation.

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

National Educational Technology Standards for Students
T1 — Basic operations and concepts
T5 — Technology research tools
T6 — Technology problem-solving and decision-making tools

STANDARDS


**Course Name:** ELT 1564 *Telephone Systems for Special Systems Electrical Technology*

**Course Abbreviation:** ELT 1564

**Classification:** Vocational–Technical Elective

**Description:** Information and hands-on experience in installation, operation, troubleshooting, and repair of residential and commercial use telephone systems including analog and digital key systems (4 sch: 3-hr lecture, 2-hr lab)

**Pre/Corequisite:** None

**Competencies and Suggested Objectives**

1. Demonstrate and practice general safety procedures in the school and work site environments.
<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>a.</td>
<td>Apply relevant and appropriate safety techniques.</td>
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<tr>
<td>b.</td>
<td>Demonstrate an understanding of and comply with relevant OSHA safety standards.</td>
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<tr>
<td>2.</td>
<td>Explain and analyze the aspects of basic telephone service.</td>
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<tr>
<td>a.</td>
<td>Explain the principal parts of the telephone and the function of each.</td>
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<td>b.</td>
<td>Analyze the characteristics of analog and digital signals.</td>
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<td>c.</td>
<td>Explain the nationwide and worldwide numbering systems.</td>
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<td>d.</td>
<td>Differentiate between landline and wireless telephone systems.</td>
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<td>e.</td>
<td>Troubleshoot systems and their applications.</td>
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<tr>
<td>3.</td>
<td>Explain and test the operation and installation of key systems.</td>
</tr>
<tr>
<td>a.</td>
<td>Describe the key system advantages and components, and their functions, voltages, and operation.</td>
</tr>
<tr>
<td>b.</td>
<td>Develop an installation plan to include results of the site survey, floor plans, set locations, equipment locations, list of materials, and costs.</td>
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<tr>
<td>c.</td>
<td>Identify, interpret, and develop a blueprint using symbols for telephone system installation.</td>
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<tr>
<td>d.</td>
<td>Install a key security system using the proper tools following manufacturer’s specifications, proper grounding procedures, and all applicable safety practices.</td>
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<tr>
<td>e.</td>
<td>Identify malfunctions in the key security system using approved troubleshooting procedures, and make repairs as necessary.</td>
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<tr>
<td>4.</td>
<td>Explain and test the operation and installation of digital key systems.</td>
</tr>
<tr>
<td>a.</td>
<td>Identify and describe the advantages and components and their functions, voltages, and operation.</td>
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<tr>
<td>b.</td>
<td>Describe the uses and limitations of block diagrams as they relate to installation.</td>
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<tr>
<td>c.</td>
<td>Explain and define the use and interconnection of data communications systems with a digital key system to include fiber interface, ISDN, and T-1s.</td>
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<tr>
<td>d.</td>
<td>Explain and outline network protocol as it pertains to the digital key system interaction with data communications networks.</td>
</tr>
<tr>
<td>e.</td>
<td>Develop an installation plan to include results of the site survey, floor plans, set locations, equipment locations, list of materials, and costs.</td>
</tr>
</tbody>
</table>
f. Install a key system using the proper tools following manufacturer’s specifications, proper grounding procedures, and all applicable safety practices.

g. Identify malfunctions in the digital key system using approved troubleshooting procedures, and make necessary repairs.

5. Install a telephone system as per applicable codes:
   a. Explain the relevant NEC and other codes used in telephone systems.
   b. Design, install, and maintain raceways systems for telephone systems.

6. Demonstrate the ability to properly terminate a telephone system:
   a. Use the system proper system tools to terminate telephone systems.
   b. Follow proper codes and standards while terming a telephone system.

7. Install various special electrical systems used in the construction process, and follow all applicable codes and standards:
   a. Install a nurse call system.
   b. Install a fire alarm system.
   c. Install a security system.

STANDARDS

*National Center for Construction Education and Research Standards*

ELT3.10 Voice, Data, and Video

ELT4.5 Fire Alarm Systems

ELT4.7 Advanced Controls

EST4.6 Broadband Systems

EST4.11 Telecommunications Systems
Related Academic Standards

C1——Interpret written material.
C2——Interpret visual materials (maps, charts, graphs, tables, etc.).
C3——Listen, comprehend, and take appropriate actions.
C4——Access, organize, and evaluate information.
C5——Use written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.
C6——Communicate ideas and information effectively using various oral and written forms for a variety of audiences and purposes.
S8——Apply concepts related to the scientific process and method to include safety procedures for classroom and laboratory; use and care of scientific equipment; interrelationships between science, technology, and society; and effective communication of scientific results in oral, written, and graphic form.

21st Century Skills

CS1——Global Awareness
CS2——Financial, Economic, and Business Literacy
CS3——Civic Literacy
CS4——Information and Communication Skills
CS5——Thinking and Problem-Solving Skills
CS6——Interpersonal and Self-Directional Skills
National Educational Technology Standards for Students

T1 — Basic operations and concepts
T2 — Social, ethical, and human issues
T3 — Technology productivity tools
T5 — Technology research tools
T6 — Technology problem-solving and decision-making tools

STANDARDS


Course Name: ELT 1614 Principles of Hydraulics and Pneumatics

Course Abbreviation: IMM 1314/ELT1614

Classification: Vocational–Technical Core (Associate degree); Vocational–Technical Elective (Certificate)
**Description:** Instruction in basic principles of hydraulics and pneumatics and the inspection, maintenance, and repair of hydraulic and pneumatic systems (4 sch: 1-hr lecture, 6-hr lab) [May be taught as a 90 contact hour lab in open entry open exit vocational programs]

**Prerequisite:** None

### Competencies and Suggested Objectives

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<tbody>
<tr>
<td>1.</td>
<td>Describe and discuss basic principles of hydraulics as related to industrial maintenance.</td>
</tr>
<tr>
<td></td>
<td>a. Identify the basic components of a hydraulic system, including fluids, filters, pumps, lines, control valves, cylinders, motors, and so forth.</td>
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<td></td>
<td>b. Interpret schematics of hydraulic systems.</td>
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<td>c. Differentiate between open and closed hydraulic systems.</td>
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<td></td>
<td>d. Practice safety precautions and procedures associated with hydraulic systems.</td>
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<td>2.</td>
<td>Inspect, maintain, and repair hydraulic systems.</td>
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<td>a. Evaluate hydraulic pumps for pressure and flow.</td>
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<td>b. Inspect hydraulic valves for leakage and proper actions.</td>
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<tr>
<td></td>
<td>c. Inspect hydraulic cylinders for leakage and proper operations.</td>
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<td>3.</td>
<td>Describe and discuss basic principles of pneumatics as associated with industrial maintenance.</td>
</tr>
<tr>
<td></td>
<td>a. Identify the components of a pneumatic system, including compressor, lines, control valves, gauges, filters, attachments, cylinders, and motors.</td>
</tr>
<tr>
<td></td>
<td>b. Interpret schematics of pneumatic systems.</td>
</tr>
<tr>
<td></td>
<td>c. Practice safety precautions and procedures associated with pneumatic systems.</td>
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<tr>
<td>4.</td>
<td>Inspect, maintain, and repair pneumatic systems.</td>
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<tr>
<td></td>
<td>a. Perform scheduled preventive maintenance on an air compressor.</td>
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<tr>
<td></td>
<td>b. Evaluate pneumatic equipment and devices for leakage and proper operation.</td>
</tr>
</tbody>
</table>

**STANDARDS**
Contren Learning Series Best Practices

IMM3.12 —— Hydraulic and Pneumatic Controls

Related Academic Standards

R1 —— Interpret Graphic Information (forms, maps, reference sources)
R2 —— Words in Context (same and opposite meaning)
R3 —— Recall Information (details, sequence)
R4 —— Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause–effect)
R5 —— Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 —— Addition of Whole Numbers (no regrouping, regrouping)
M2 —— Subtraction of Whole Numbers (no regrouping, regrouping)
M3 —— Multiplication of Whole Numbers (no regrouping, regrouping)
M4 —— Division of Whole Numbers (no remainder, remainder)
M5 —— Decimals (addition, subtraction, multiplication, division)
M6 —— Fractions (addition, subtraction, multiplication, division)
A3 —— Data Interpretation (graph, table, chart, diagram)
A4 —— Pre-Algebra and Algebra (equations, inequality)
A5 —— Measurement (money, time, temperature, length, area, volume)
A6 —— Geometry (angles, Pythagorean theory)
A7 —— Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 —— Estimation (rounding, estimation)
L1 —— Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
21st Century Skills

CS2 — Financial, Economic, and Business Literacy
CS3 — Civic Literacy
CS4 — Information and Communication Skills
CS5 — Thinking and Problem-Solving Skills
CS6 — Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES


**Course Name:**

**ELT 2113-4 Equipment Maintenance, Troubleshooting, and Repair**

**Course Abbreviation:** IMM 2114/ELT 2114

**Classification:** Vocational–Technical Core (Associate degree); Vocational–Technical Elective (Certificate)

**Description:** Maintenance and troubleshooting techniques, use of technical manuals and test equipment, and inspection/evaluation/repair of equipment (4 sch: 1-hr lecture, 6-hr lab)

**Prerequisite:** None

**Competencies and Suggested Objectives**

<table>
<thead>
<tr>
<th>Competency</th>
<th>Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Discuss and apply proper safety procedures regarding maintenance, troubleshooting, and repair of equipment.</td>
</tr>
<tr>
<td>2.</td>
<td>Perform preventive maintenance on equipment.</td>
</tr>
<tr>
<td></td>
<td>a. Develop a preventive maintenance program for a given piece of equipment.</td>
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<tr>
<td></td>
<td>b. Inspect and adjust belts, chains, and other moving parts.</td>
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<td></td>
<td>c. Lubricate a machine following manufacturer’s recommendations.</td>
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<tr>
<td>3.</td>
<td>Troubleshoot and repair equipment.</td>
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<tr>
<td></td>
<td>a. Identify symptoms that indicate a machine is not operating properly (excessive noise, vibration, heat, speed, etc.).</td>
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<td></td>
<td>b. Determine the cause of the symptoms.</td>
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<td></td>
<td>c. Inspect machinery for broken or worn parts, and determine if replacement is needed.</td>
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<tr>
<td></td>
<td>d. Prepare a report on time and costs involved in repairing equipment.</td>
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<tr>
<td></td>
<td>e. Perform tagout-lockout procedures for broken equipment.</td>
</tr>
</tbody>
</table>
f. Disassemble, inspect, repair, and reassemble equipment to specifications.

g. Perform preventive maintenance on an electric motor (disassemble, clean and inspect, repair mechanical components, lubricate, and reassemble).

h. Check and service a battery, including recharging.

4. Estimate expenses for a given project.

a. Prepare a bill of materials list for a specific job.

b. Calculate the labor factor for a specific job.

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**STANDARDS**

Contren Learning Series Best Practices

ELT4.8 — HVAC Controls

IMM3.12 — Hydraulic and Pneumatic Controls

Related Academic Standards

R1 — Interpret Graphic Information (forms, maps, reference sources)

R2 — Words in Context (same and opposite meaning)

R3 — Recall Information (details, sequence)

R4 — Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause–effect)

R5 — Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)

M1 — Addition of Whole Numbers (no regrouping, regrouping)

M2 — Subtraction of Whole Numbers (no regrouping, regrouping)

M3 — Multiplication of Whole Numbers (no regrouping, regrouping)

M4 — Division of Whole Numbers (no remainder, remainder)
M5—Decimals (addition, subtraction, multiplication, division)
M6—Fractions (addition, subtraction, multiplication, division)
M7—Integers (addition, subtraction, multiplication, division)
A3—Data Interpretation (graph, table, chart, diagram)
A4—Pre-Algebra and Algebra (equations, inequality)
A5—Measurement (money, time, temperature, length, area, volume)
A6—Geometry (angles, Pythagorean theory)
A7—Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8—Estimation (rounding, estimation)
L1—Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2—Sentence Formation (fragments, run-on, clarity)
L3—Paragraph Development (topic sentence, supporting sentence, sequence)
L4—Capitalization (proper noun, titles)
L5—Punctuation (comma, semicolon)
L6—Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1—Vowel (short, long)
S2—Consonant (variant spelling, silent letter)
S3—Structural Unit (root, suffix)

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21st Century Skills

CS2—Financial, Economic, and Business Literacy
CS3—Civic Literacy
CS4—Information and Communication Skills
CS5 Thinking and Problem-Solving Skills

CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES


**Course Name:**

**ELT 2424 Solid State Motor Control**

**Course Abbreviation:** ELT-2424

**Classification:** Vocational–Technical Core (Associate degree), Vocational–Technical Elective (Technical Certificate)

**Description:** Principles and operation of solid state motor control. Also, the design, installation, and maintenance of different solid state devices for motor control (4 sch: 2-hr lecture, 4-hr lab)
**Pre/Corequisites:** Motor Control Systems (ELT 1413), Programmable Logic Controllers (ELT 2613), or by permission of instructor

### Competencies and Suggested Objectives

1. **Apply general safety and safety requirements for working on and around electrical motors.**
   - a. Apply principles of safety in the use of electrical motors.
   - b. Describe safety procedures to utilize during connecting and operating electric motors.

2. **Troubleshoot solid state motor controls.**
   - a. Identify electronic and industrial symbols used to represent logic gates in solid state schematics.
   - b. Describe the operation of the different types of industrial and electronic logic gates.
   - c. Draw a solid state logic circuit to replace a manual control station.
   - d. Troubleshoot and repair/replace solid state devices to include memory devices, flip/flops, adjustable time delays, starting and stopping sequences, and looping.

3. **Operate AC and DC variable speed drives.**
   - a. Discuss the operation of a DC variable speed drive.
   - b. Discuss the operation of an AC variable speed drive.
   - c. Connect and operate a DC and AC variable speed drive.

### STANDARDS

**National Center for Construction Education and Research Standards**

ELT4.7—Advanced Controls

**Related Academic Standards**
C1 Interpret written material.

C2 Interpret visual materials (maps, charts, graphs, tables, etc.).

C3 Listen, comprehend, and take appropriate actions.

C4 Access, organize, and evaluate information.

C5 Use written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.

C6 Communicate ideas and information effectively using various oral and written forms for a variety of audiences and purposes.

M7 Apply mathematical methods, concepts, and properties to solve a variety of real-world problems.

S8 Apply concepts related to the scientific process and method to include safety procedures for classroom and laboratory; use and care of scientific equipment; interrelationships between science, technology, and society; and effective communication of scientific results in oral, written, and graphic form.

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21st Century Skills

CS1 Global Awareness

CS2 Financial, Economic, and Business Literacy

CS3 Civic Literacy

CS4 Information and Communication Skills

CS5 Thinking and Problem-Solving Skills

CS6 Interpersonal and Self-Directional Skills

National Educational Technology Standards for Students
T1 Basic operations and concepts
T3 Technology productivity tools
T4 Technology communications tools
T5 Technology research tools
T6 Technology problem-solving and decision-making tools

SUGGESTED REFERENCES


Course Name: Programmable Logic Controllers

Course Abbreviation: ELT 2613

Classification: Vocational–Technical Core (Associate degree), Vocational–Technical Elective (Certificate)

Description: Use of programmable logic controllers (PLCs) in modern industrial settings. Also, the operating principles of PLCs and practice in the programming, installation, and maintenance of PLCs (3 sch: 2-hr lecture, 2-hr lab.)

Prerequisites: Motor Control Systems (ELT 1413) or by permission of instructor

Competencies and Suggested Objectives

1. Explain principles of PLCs.
   a. Identify components and operational principles of PLCs.
   b. Differentiate between a PLC and a computer.

2. Identify different types of PLC hardware.
   a. Identify and wire different types of input and output modules.
   b. Identify different types of PLC processor modules, memory capabilities, and programming devices.

3. Explain numbering systems, encoding/decoding, and logical operations.
   a. Convert numbers from one system to another.
   b. Explain logical operations using truth tables and ladder logic diagrams.

4. Program all types of internal and discrete instructions.
   a. Program examine on and off instructions.
   b. Program on-delay and off-delay instructions.
c. Program up-counter and down-counter instructions.

d. Program sequencer instructions for real-world output devices.

e. Program latch and unlatch instructions.

5. Troubleshoot and maintain different programmable controllers systems.

   a. Identify and troubleshoot the power supply.

   b. Identify and troubleshoot the inputs and outputs (I/O) cards.

   c. Identify and troubleshoot real-world inputs and outputs.

STANDARDS

National Center for Construction Education and Research Standards

ELT3.11 Motor Controls

ELT4.6 Specialty Transformers

ELT4.7 Advanced Controls

ELT4.8 HVAC Controls

Related Academic Standards

C1 Interpret written material.

C4 Access, organize, and evaluate information.

C5 Use written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.

C6 Communicate ideas and information effectively using various oral and written forms for a variety of audiences and purposes.

M1 Relate number relationships, number systems, and number theory.
M7—Apply mathematical methods, concepts, and properties to solve a variety of real-world problems.

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21st Century Skills

CS1—Global Awareness
CS2—Financial, Economic, and Business Literacy
CS3—Civic Literacy
CS4—Information and Communication Skills
CS5—Thinking and Problem-Solving Skills
CS6—Interpersonal and Self-Directional Skills

National Educational Technology Standards for Students

T1—Basic operations and concepts
T3—Technology productivity tools
T4—Technology communications tools
T5—Technology research tools
T6—Technology problem-solving and decision-making tools

SUGGESTED REFERENCES


ELT 2613 Programmable Logic Controllers


ELT 2623 Advanced Programmable Logic Controllers

Course Abbreviations: ELT 2623

Classification: Vocational–Technical Elective

Description: Advanced PLC course that provides instruction in the various operations, installations, and maintenance of electric motor controls. Also, information in such areas as sequencer, program control, block transfer used in analog input and output programming, and logical and conversion instructions (3 sch: 2-hr lecture, 2-hr lab)

Prerequisites: Programmable Logic Controllers (ELT 2613) and Motor Control Systems (ELT 1413) or by permission of instructor

Competencies and Suggested Objectives

1. Program all types of high order instructions.
   a. Calculate and develop mathematical instructions to include addition, subtraction, multiplication, and division.
   b. Program and set up a chart for input and output sequencer combination.
   c. Program shift left and shift right instructions.
   d. Program block transfer read and block transfer write instructions.
1. Troubleshoot advanced PLC controls.
   a. Troubleshoot an analog input and output card.
   b. Troubleshoot communication devices used in networking.

2. Program and set up an analog input and output card using PLC software.

STANDARDS

National Center for Construction Education and Research Standards

ELT3.11 Motor Controls
ELT4.6 Specialty Transformers
ELT4.7 Advanced Controls
ELT4.8 HVAC Controls

Related Academic Standards

C1—Interpret written material.
C2—Interpret visual materials (maps, charts, graphs, tables, etc.).
C4—Access, organize, and evaluate information.
C5—Use written and/or oral language skills to work cooperatively to solve problems, make decisions, take actions, and reach agreement.
M1—Relate number relationships, number systems, and number theory.
M2—Explore patterns and functions.
M7—Apply mathematical methods, concepts, and properties to solve a variety of real-world problems.

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21st Century Skills

CS1——Global Awareness
CS2——Financial, Economic, and Business Literacy
CS3——Civic Literacy
CS4——Information and Communication Skills
CS5——Thinking and Problem-Solving Skills
CS6——Interpersonal and Self-Directional Skills

National Educational Technology Standards for Students

T1——Basic operations and concepts
T3——Technology productivity tools
T4——Technology communications tools
T5——Technology research tools
T6——Technology problem-solving and decision-making tools

SUGGESTED REFERENCES


Course Name: Special Project I, II

Course Abbreviation: ELT 291(1–3), ELT 293(1–3)
Appendix B: Standards for the NCCER

**Classification:** Vocational–Technical Elective

**Description:** Practical application of skills and knowledge gained in other electrical or electrical-related technical courses. The instructor works closely with the student to insure that the selection of a project will enhance the student’s learning experience. (1–3 sch: 2–6 hr lab)

**Prerequisites:** Consent of instructor

**NCCER Electrician**

ELT1.1 Orientation to the Electrical Trade (Module 26101.11)
ELT1.2 Electrical Safety (Module 26102-11)
ELT1.3 Introduction to Electrical Circuits (Module 26103.11)
ELT1.4 Electrical Theory (Module 26104.11)
ELT1.5 Introduction to the National Electrical Code (Module 26105.11)
ELT1.6 Device Boxes (Module 26106.11)
ELT1.7 Hand Bending (Module 26107.11)
ELT1.8 Raceways and Fittings (Module 26108.11)
ELT1.9 Conductors and Cables (Module 26109-11)
ELT1.10 Basic Electrical Construction Drawings (Module 26110-11)
ELT1.11 Residential Electrical Services (Module 26111-11)
ELT1.12 Electrical Test Equipment (Module 26112-11)

ELT2.1 Alternating Current (Module 26201-11)
ELT2.2 Motors: Theory and Application (Module 26202-11)
ELT2.3 Electric Lighting (Module 26203-11)
ELT2.4 Conduit Bending (Module 26204-11)
ELT2.5 Pull and Junction Boxes (Module 26205-11)
ELT2.6 Conductor Installations (Module 26206-11)
ELT2.7 Cable Tray (Module 26207-11)
ELT2.8 Conductor Terminations and Splices (Module 26208-11)
ELT2.9 Grounding and Bonding (Module 26209-11)
ELT2.10 Circuit Breakers and Fuses (Module 26210-11)

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ELT2.11  Control Systems and Fundamental Concepts (Module 26211-11)

ELT3.1  Load Calculations – Branch and Feeder Circuits (Module 26301-11)
ELT3.2  Conductor Selection and Calculations (Module 26302-11)
ELT3.3  Practical Applications of Lighting (Module 26303-11)
ELT3.4  Hazardous Locations (Module 26304-11)
ELT3.5  Overcurrent Protection (Module 26305-11)
ELT3.6  Distribution Equipment (Module 26306-11)
ELT3.7  Transformers (Module 26307-11)
ELT3.8  Commercial Electrical Services (Module 26308-11)
ELT3.9  Motor Calculations (Module 26309-11)
ELT3.10  Voice, Data, and Video (Module 26310-11)
ELT3.11  Motor Controls (Module 26311-11)

ELT4.1  Load Calculations – Feeders and Services (Module 26401-11)
ELT4.2  Health Care Facilities (Module 26402-11)
ELT4.3  Standby and Emergency Systems (Module 26403-11)
ELT4.4  Basic Electronic Theory (Module 26404-11)
ELT4.5  Fire Alarm Systems (Module 26405-11)
ELT4.6  Specialty Transformers (Module 26406-11)
ELT4.7  Advanced Controls (Module 26407-11)
ELT4.8  HVAC Controls (Module 26408-11)
ELT4.9  Heat Tracing and Freeze Protection (Module 26409-11)
ELT4.10  Motor Operation and Maintenance (Module 26410-11)
ELT4.11  Medium-Voltage Terminations/Splices (Module 26411-11)
ELT4.12  Special Locations (Module 26412-11)

NCCER Instrumentation

INS1.1  Hand Tools for Instrumentation (Module 12101-01)
INS1.2  Electrical Safety (Module 12102-01)
INS1.3  Power Tools for Instrumentation (Module 12103-01)
INS1.4  Electrical Systems for Instrumentation (Module 12104-01)
INS1.5  Metallurgy for Instrumentation (Module 12105-01)
INS1.6  Fasteners (Module 12106-01)
INS1.7  Instrumentation Drawings and Documents, Part One (Module 12107-01)
INS1.8  Gaskets and Packing (Module 12108-01)
INS1.9  Lubricants, Sealants, and Cleaners (Module 12109-01)
INS1.10  Flow, Pressure, Level, and Temperature (Module 12110-01)
INS1.11  Tubing (Module 12111-01)
INS1.12  Piping - 2 in. and Under (Module 12112-01)
INS1.13  Hoses (Module 12113-01)

INS2.1  Craft-Related Mathematics (Module 12201-03)
INS2.2  Instrumentation Drawings and Documents, Part Two (Module 12202-03)
INS2.3  Principles of Welding for Instrumentation (Module 12203-03)
INS2.4  Process Control Theory (Module 12204-03)
INS2.5 Detectors, Secondary Elements, Transducers, and Transmitters (Module 12205-03)
INS2.6 Controllers, Recorders, and Indicators (Module 12206-03)
INS2.7 Control Valves, Actuators, and Positioners (Module 12207-03)
INS2.8 Relays and Timers (Module 12208-03)
INS2.9 Switches and Photocell Devices (Module 12209-03)
INS2.10 Filters, Regulators, and Dryers (Module 12210-03)
INS2.11 Analyzers and Monitors (Module 12211-03)
INS2.12 Panel-Mounted Instruments (Module 12212-03)
INS2.13 Installing Field-Mounted Instruments (Module 12213-03)
INS2.14 Raceways for Instrumentation (Module 12214-03)

NCCER Industrial Maintenance: Electrical and Instrumentation

IMM3.1 Hazardous Locations (Module 40301-09)
IMM3.2 Electronic Components (Module 40302-09)
IMM3.3 E & I Drawings (Module 40303-09)
IMM3.4 Motor Controls (Module 40304-09)
IMM3.5 Distribution Equipment (Module 40305-09)
IMM3.6 Transformer Applications (Module 40306-09)
IMM3.7 Conductor Selection and Calculations (Module 40307-09)
IMM3.8 Temporary Grounding (Module 40308-09)
IMM3.9 Pipe Layout and Installation (Module 40309-09)
IMM3.10 Machine Bending of Conduit (Module 40310-09)
IMM3.11 Hydraulic Controls (Module 40311-09)
IMM3.12 Pneumatic Controls (Module 40312-09)
IMM3.13 Motor-Operated Valves (Module 40313-09)

NCCER Electronic Systems Technician

EST1.1 Introduction to the Trade (Module 33101-10)
EST1.2 Wood and Masonry Construction Methods (Module 33102-10)
EST1.3 Concrete and Steel Construction Methods (Module 33103-10)
EST1.4 Pathways and Spaces (Module 33104-10)
EST1.5 Craft-Related Mathematics (Module 33105-10)
EST1.6 Hand Bending of Conduit (Module 33106-10)
EST1.7 Introduction to the National Electrical Code (Module 33107-10)
EST1.8 Low-Voltage Cabling (Module 33108-10)

EST2.1 DC Circuits (Module 33201-10)
EST2.2 AC Circuits (Module 33202-10)
EST2.3 Switching Devices and Timers (Module 33203-10)
EST2.4 Semiconductors and Integrated Circuits (Module 33204-10)
EST2.5 Basic Test Equipment (Module 33205-10)
EST2.6 Introduction to Electrical Drawings (Module 33206-10)
EST2.7 Introduction to Codes and Standards (Module 33207-10)
EST2.8 Cable Selection (Module 33208-10)
EST2.9 Wire and Cable Terminations (Module 33209-10)
EST2.10 Power Quality and Grounding (Module 33210-10)

EST3.1 Buses and Networks (Module 33301-11)
EST3.2 Fiber Optics (Module 33302-11)
EST3.3 Wireless Communication (Module 33303-11)
EST3.4 Site Survey, Project Planning, and Documentation (Module 33304-11)
MT101 Fundamentals of Crew Leadership (Module 46101-11)
EST3.5 Rack Assembly (Module 33305-11)
EST3.6 Systems Commissioning and User Training (Module 33306-11)
EST3.7 Maintenance and Repair (Module 33307-11)

EST4.1 Fire Alarm Systems (Module 33401-03)
EST4.2 Intrusion Detection Systems (Module 33402-03)
EST4.3 Audio Systems (Module 33403-03)
EST4.4 Overview of Nurse Call and Signaling Systems (Module 33404-03)
EST4.5 CCTV Systems (Module 33405-03)
EST4.6 Broadband Systems (Module 33406-03)
EST4.7 Access Control Systems (Module 33407-03)
EST4.8 Systems Integration (Module 33408-03)
EST4.10 Media Management Systems (Module 33410-03)
EST4.11 Telecommunications Systems (Module 33411-05)
Appendix C: Related Academic Standards

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
<th>Related Academic Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Develop a written plan and blueprints that detail the activities and projects to be completed.</td>
<td>Course</td>
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<tr>
<td>a. Utilize a written plan that details the activities and projects to be completed.</td>
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<tr>
<td>b. Perform written occupational objectives in the special project.</td>
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<td>2. Assess accomplishment of objectives.</td>
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<tr>
<td>a. Prepare daily written assessment of accomplishment of objectives.</td>
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<tr>
<td>b. Present weekly written reports to the</td>
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3. Utilize a set of written guidelines for the special project:
   a. Develop and follow a set of written guidelines for the special project. R1

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Specific standards for this course will depend upon the nature of the problem under investigation.

Specific references for this course will depend upon the nature of the problem under investigation.
Course Name: Supervised Work Experience I, II

Course Abbreviation: ELT 292(1–6), ELT 294(1–6)

Classification: Vocational–Technical Elective

Description: A cooperative program between industry and education and is designed to integrate the student’s technical studies with industrial experience. Variable credit is awarded on the basis of semester hour per 45 industrial contact hours. (1–6 sch: 3–18 hr externship)

Prerequisites: Consent of instructor and completion of at least one semester of advanced coursework in electrical/electronics related programs

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
<th>Related Academic Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Apply technical skills needed to be a viable member of the workforce.</td>
<td>Course</td>
</tr>
<tr>
<td>a. Prepare a description of technical skills to be developed in the supervised work experience program.</td>
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<tr>
<td>b. Develop technical skills needed to be a viable member of the workforce.</td>
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<td>2. Apply skills developed in</td>
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<td>other program area courses.</td>
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<tr>
<td>a. Perform skills developed in other program area courses in the supervised work experience program.</td>
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<tr>
<td>3. Apply human relationship skills.</td>
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<tr>
<td>a. Practice human relationship skills in the supervised work experience program.</td>
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<td>4. Apply and practice positive work habits and responsibilities.</td>
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<tr>
<td>a. Perform assignments to develop positive work habits and responsibilities.</td>
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<tr>
<td>5. Work with the instructor and employer to develop written occupational objectives to be accomplished.</td>
<td></td>
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<tr>
<td>a. Perform written occupational objectives in the supervised occupational experience program.</td>
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<tr>
<td>6. Assess</td>
<td>X</td>
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</table>
accomplishment of objectives.

a. Prepare daily written assessment of accomplishment of objectives.

b. Present weekly written reports to instructor in activities performed and objectives accomplished. \(^{R4}\)

7. Utilize a set of written guidelines for the supervised work experience.

a. Develop and follow a set of written guidelines for the supervised work experience. \(^{R5}\)

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Specific standards for this course will depend upon the nature of the problem under investigation.

Specific references for this course will depend upon the nature of the problem under investigation.
Recommended Tools and Equipment

**CAPITALIZED ITEMS**

1. Digital megohm meter (1)
2. Oscopes (1 per 2 students)
3. Ratchet conduit bender 1/2 in. to 1 in. (1)
4. Hydraulic conduit bender 1 1/4 in. to 2 in. (1)
5. PVC bender up to 2 in. (1)
6. 1/2 to 2 in. hydraulic knock-out cutters (1)
7. 1/2 to 2 in. hand threaders (1)
8. Handheld electric pipe threaders, 1/2 to 2 in. (1)
9. Power threader up to 2 in. (1)
10. Power threader PTO driven (1)
11. Power fish system (1)
12. Sets stack scaffold with wheels (2 stacks)
13. Electric wire pulling system (1)
14. Pedestal drill press (1)
15. Electric portable band-saw (1)
16. Circular band electric saw (1)
17. Rota hammer/Hammer drill (1)
18. 4 ft (1 per 2 students), 6 ft (1 per 2 students), 8 ft (1), 10 ft (1), and 12 ft (1) fiberglass stepladders
19. Fiberglass extension ladder, 14 ft (1)
20. Work tables (1 per 2 students)
21. Variable speed motor trainers, AC and DC (2)
22. PLC trainers with troubleshooting capabilities (1 per 2 students)
23. Computers (1 per 2 students)
24. Industrial motor control trainers, AC and DC (1 per 2 students)
25. Input/output analog trainers (1 per 2 students)
26. Electro/mechanical trainers (3)
27. Motor control troubleshooting trainers (1 per 2 students)
28. AC/DC trainers (1 per 2 students)
29. Fire alarm trainers (1)
30. Burglar alarm trainers (1)
31. Digital trainers (1 per 2 students)
32. Air compressor (1)
33. Fiber-optic splicing kits (cleaver included) (1 per 2 students)
34. Db loss meters/fiber-optic (2)
35. Fusion splicer/fiber-optic (1)
36. Portable generator (1)
37. Manual transfer switch (1)
38. Automatic transfer switch (1)
39. Transformer trainer (2)
40. Power supply trainer (2)
41. Thermal imagining camera (1)
42. Earth ground tester (1)

NON-CAPITALIZED ITEMS

1. Electrical hand tools: Lineman pliers, wire strippers, screwdrivers, needlenose pliers, tool pouch, ruler, folding rule, and safety glasses (1 set per student)
2. Digital VOM (1 per 2 students)
3. Analog VOM (1 per 2 students)
4. Ammeter (2)
5. Watt meter (1)
6. Tachometer (2)
7. Hand conduit benders, 1/2 in., 3/4 in., 1 in. (1 each)
8. Electric drills, 1/2 in. and 3/8 in. (1 each)
9. Rechargeable electric drills (1)
10. 1/2 to 2-in. manual knock-out cutters (1)
11. Pedestal grinders (1)
12. Hand grinder/polisher (1)
13. Reciprocating portable saw (1)
14. Pipe reamer (1)
15. Portable jig saw (1)
16. Right angle drill 1/2 in. (1)
17. Chain pipe vises on tripod (1)
18. Machinist vise (1)
19. Wet/dry shop vacuum (1)
20. AC and DC amp meter (1)

RECOMMENDED INSTRUCTIONAL AIDS

It is recommended that instructors have access to the following items:

1. Scientific calculator (1)
2. Computer with operating software with multimedia kit (1)
3. VCR/DVD player (1)
4. Data projector (1)
5. Laptop computer (1)
6. Smart Board (1)
7. Document camera
8. Digital camera
9. Video camera
Student Competency Profile for Electrical Technology

Student: __________________________________________________

This record is intended to serve as a method of noting student achievement of the competencies in each course. It can be duplicated for each student and serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Residential/Light Commercial Wiring (ELT 1113)

-----1. Read and utilize drawings of a structure.

-----2. Stimulate wiring a residence and/or commercial building according to the current NEC and local codes.

-----3. Discuss current protective devices, load centers, panel boards, and safety switches.

Commercial and Industrial Wiring (ELT 1123)

-----1. Apply general safety rules and current NEC and local codes.

-----2. Install and maintain raceways, conduit, and fittings.

-----3. Explain different types of three-phase service entrances, metering devices, main panels, raceways or ducts, subpanels, feeder circuits, and branch circuits according to electrical codes.

-----4. Prepare a job estimate including supplies and labor costs.

Introduction to the National Electric Code (ELT 1133)
1. Use the NEC as a reference manual to locate information, and give a reference of where the information can be found.

AC and DC Circuits for Electrical Technology (ELT 1144)

1. Demonstrate and practice general safety procedures in the school and work site environments.

2. Demonstrate and apply a basic electrical circuit.

3. Demonstrate the meaning of and relationships among and between voltage, current, resistance, and power in AC and DC circuits.

4. Analyze and evaluate the parameters of AC and DC series circuits.

5. Analyze and evaluate the parameters of AC and DC parallel circuits.

6. Analyze and evaluate the parameters of AC and DC series-parallel circuit.

7. Analyze inductive and capacitive reactance in series and parallel circuits.

8. Analyze transformer voltage, current, impedance transformations, and applications.
Drafting for Electrical Technology (ELT 1163)

_____1. Demonstrate an understanding of drafting fundamentals utilizing both hand- and computer-aided drafting and how it relates to the electrical industry.

_____2. Demonstrate an understanding of electrical symbols, components, and references used in schematic and logic diagrams.

_____3. Demonstrate the ability to compose projections, electrical drawings, and diagrams.

_____4. Demonstrate an understanding of electronics drafting using CAD.

Fundamentals of Electricity (ELT 1192–3)

_____1. Apply general safety procedures in the shop, lab, and industrial environment.

_____2. Demonstrate use of electrical tools, equipment, and references.

_____3. Solve problems using Ohm’s law.

Electrical Power (ELT 1213)

_____1. Discuss safety and environmental protection concerns associated with electrical power equipment.

_____2. Wire single-phase electrical components.

_____3. Wire three-phase electrical components.

Motor Maintenance and Troubleshooting (ELT 1223)

_____1. Apply general safety and safety requirements for working with electric motors.

_____2. Use instruments and tools in maintaining, troubleshooting, and operating electrical motors.

_____3. Troubleshoot and perform basic maintenance on electric motors.

Branch Circuit and Service Entrance Calculations (ELT 1253)

_____1. Explain size and color of equipment grounding conductors for all branch circuits.
2. Determine the minimum number of general purpose branch circuits needed in a residential structure.
3. Calculate the branch circuit sizes for individual branch circuits for residential wiring.
4. Calculate the minimum number of branch circuits of the small appliance and laundry types.
5. Explain and demonstrate the procedure for calculating the residential service entrance conductor size using the standard or optional method according to NEC.

Blueprint Reading/Planning in Residential Installation (ELT 1263)

1. Explain ANSI symbols used in blueprint reading.
2. Explain plans and elevations critical to blueprint reading.
3. Determine service entrance locations and heights.
4. Locate vertical wall receptacles, switches, and lighting outlets.
5. Prepare blueprints to meet NEC minimum requirements.

Switching Circuits for Residential, Commercial, and Industrial Applications (ELT 1273)

1. Demonstrate various switching circuits.
2. Demonstrate low voltage remote and relay control wiring.

Estimating the Cost of an Electrical Installation (ELT 1283)

1. Calculate the total projected cost of materials and labor by using the results of a time and motion study, actual cost of materials, and margin of profit.
2. Prepare a branch circuit schedule.

Automated Manufacturing Controls for Electrical Technology (ELT 1313)

1. Demonstrate the ability to develop a robotics process utilized in the electrical industry.
2. Demonstrate the ability to interface components of a robotics process and how they relate to the electrical industry.
3. Demonstrate the ability to evaluate and troubleshoot a robotics process.

Calibration and Measurement Principles used in the Electrical Industry (ELT 1324)

1. Define terms associated with measurement and calibration procedures used in the electrical industry.
2. Describe a standard calibration procedure used in the electrical industry.
Flexible Manufacturing Systems for Electrical Technology (ELT 1334)

1. Plan a project that will utilize the automated system used in the electrical industry.
2. Plan and specify the automation equipment required for the electrical project.
3. Develop and program the project.
4. Test and debug the project.

Fundamentals of Instrumentation (ELT 1343)

1. Demonstrate a working knowledge of instrumentation as it pertains to the electrical industry.
2. Identify the type of instrumentation input and output devices, and describe their applications.
3. Identify the types of electrical signals used in instrumentation.
4. Describe fundamentals of electrical and electronic process controls.
5. Design a preventive maintenance program for instrumentation systems.

Fundamentals of Robotics for Electrical Technology (ELT 1353)

1. Describe the various major components of all robots.
2. Demonstrate safety procedures used in the automated environment.
3. Demonstrate the ability to operate robots.

Industrial Hydraulics for Electrical Technology (ELT 1363)

1. Define and describe basic laws governing liquids.
2. Identify and draw symbols for hydraulics used in the electrical industry.
3. Describe operation and nomenclature of various pumps.
4. Explain liquids as pertaining to the transmission of energy.
5. Describe the operation of flow, pressure, and directional control valves.
6. Explain the types of actuators used in hydraulics.
7. Explain, construct, and troubleshoot various hydraulic applications in the electrical industry.
8. Demonstrate the ability to interface electrical and hydraulic circuits.

Industrial Pneumatics for Electrical Technology (ELT 1373)

1. Define and describe basic laws governing gases.
2. Identify and draw symbols for pneumatics used in the electrical industry.
3. Describe the operation and nomenclature of various compressors.
4. Explain fluids as pertaining to the transmission of energy.
5. Describe the operation of flow, pressure, and directional control valves.
6. Explain the types of actuators used in pneumatic applications in the electrical technology.
7. Explain, construct, and troubleshoot various pneumatic circuits utilizing pneumatic, electrical, and electronic controls.
8. Demonstrate the use of electromechanical controls in hydraulic and pneumatic circuits.

Industrial Robotics for Electrical Technology (ELT 1383)

1. Demonstrate the ability to integrate a robot into a process affiliated to the electrical industry.
2. Demonstrate the ability to integrate peripheral equipment.
3. Demonstrate the ability to troubleshoot and maintain a robotics work cell.
Servo Control Systems for Electrical Technology (ELT 1393)

1. Identify and discuss the components and characteristics of a servo system used in the electrical industry.

2. Demonstrate the ability to construct and analyze open loop and closed loop systems.

3. Demonstrate the ability to troubleshoot and repair a servo control system used in the electrical industry.

Motor Control Systems (ELT 1413)

1. Install different control circuits and devices.

2. Troubleshoot different control circuits and devices.

Solid State Devices and Circuits for Electrical Technology (ELT 1434)

1. Explain the characteristics of semiconductor materials and theory of operation of PN junctions.

2. Explain semiconductor diode theory and apply to diode circuits.

3. Analyze the operation of semiconductor special purpose diodes.

4. Analyze the operation of bipolar junction transistors.

5. Explain and analyze the construction of BJT amplifiers.

6. Analyze the operation of field effect transistors, and demonstrate their applications.

7. Analyze the operation of thyristors, and demonstrate their applications.

Data Acquisition and Communications (ELT 1513)

1. Explain data communication components used in automatic systems.

2. Use data communications software PLC and computer to connect a network.

3. Use computers and/or controllers for data acquisition.

Fundamentals of Fiber Optics for Electrical Technology (ELT 1523)

1. Demonstrate and practice general safety procedures in the school and work site environments.

2. Describe the history and advantages of fiber optic systems and how they relate to the electrical industry.

3. Explain the operation and application of optical signal sources.

4. Explain the operation and application of fiber optic system components.

5. Describe properties of different types of optical fibers.
6. Explain the installation, connection, terminations, and maintenance of a fiber-optic system in residential and commercial applications.

7. Demonstrate an understanding of how fiber optics are covered by the NER.

8. Demonstrate the proper methods for termination of fiber optics.

Fundamentals to Data Communications for Electrical Technology (ELT 1533)

1. Discuss basic communications and how they relate to the electrical industry in modern manufacturing plants.

2. Analyze hardware, media, and software for use in data communication used between PLCs and computers in manufacturing plants.

3. Discuss communications networks and the installation of each.

4. Discuss the future of communication and the electrical industry within manufacturing plants.

5. Demonstrate the use of the Internet.

Network Systems for Electrical Technology (ELT 1544)

1. Demonstrate and practice general safety procedures in the school and work site environments.

2. Discuss, describe, apply network fundamentals, and install network software used in the Industrial manufacturing plants.

3. Discuss internetworking devices.

4. Discuss and describe voice networks, and troubleshoot network communications interface.

5. Discuss, install, and troubleshoot LANs.

6. Access the Internet.

Satellite Systems (ELT 1553)

1. Demonstrate and practice general safety procedures in the school and work site environments.

2. Identify and describe the basic principles and types of satellite systems.

3. Install, align, and service satellite systems in commercial and residential locations.

4. Identify specific NEC (references of the use of special systems and other).

Telephone Systems for Special Systems Electrical Technology (ELT 1564)

1. Demonstrate and practice general safety procedures in the school and work site environments.

2. Explain and analyze the aspects of basic telephone service.

3. Explain and test the operation and installation of key systems.

4. Explain and test the operation and installation of digital key systems.

5. Install a telephone system as per applicable codes.

6. Demonstrate the ability to properly terminate a telephone system.
7. Install various special electrical systems used in the construction process, and follow all applicable codes and standards.

Principles of Hydraulics and Pneumatics (IMM 1314/ELT 1614)

1. Describe and discuss basic principles of hydraulics as related to industrial maintenance.
2. Inspect, maintain, and repair hydraulic systems.
3. Describe and discuss basic principles of pneumatics as associated with industrial maintenance.
4. Inspect, maintain, and repair pneumatic systems.

Equipment Maintenance, Troubleshooting, and Repair (IMM 2114/ELT 2114)

1. Discuss and apply proper safety procedures regarding maintenance, troubleshooting, and repair of equipment.
2. Perform preventive maintenance on equipment.
3. Troubleshoot and repair equipment.
4. Estimate expenses for a given project.

Solid State Motor Control (ELT 2424)

1. Apply general safety and safety requirements for working on and around electrical motors.
2. Troubleshoot solid state motor controls.
3. Operate AC and DC variable speed drives.

Programmable Logic Controllers (ELT 2613)

1. Explain principles of PLCs.
2. Identify different types of PLC hardware.
3. Explain numbering systems, encoding/decoding, and logical operations.
4. Program all types of internal and discrete instructions.
5. Troubleshoot and maintain different programmable controllers systems.

Advanced Programmable Logic Controllers (ELT 2623)

1. Program all types of high order instructions.
2. Troubleshoot advanced PLC controls.

Special Project [ELT 291(1–3)]

1. Develop a written plan and blueprints that detail the activities and projects to be completed.
2. Assess accomplishment of objectives.
3. Utilize a set of written guidelines for the special project.
Supervised Work Experience [ELT 292(1–6)]

1. Apply technical skills needed to be a viable member of the workforce.
2. Apply skills developed in other program area courses.
3. Apply human relationship skills.
4. Apply and practice positive work habits and responsibilities.
5. Work with the instructor and employer to develop written occupational objectives to be accomplished.
6. Assess accomplishment of objectives.
7. Utilize a set of written guidelines for the supervised work experience.
Baseline Competencies

The following competencies and suggested objectives are taken from the publication *Mississippi Curriculum Framework for Electrician*. These competencies and objectives represent the baseline that was used to develop the community/junior college electrical technology courses. Students enrolled in postsecondary courses should either have documented mastery of these competencies or be provided with these competencies before studying the advanced competencies in the Electrical Technology program.

Baseline competencies may be integrated into existing courses in the curriculum or taught as special “Introduction” courses. The “Introduction” courses may be taught for up to 6 semester hours of institutional credit and may be divided into two courses. If the Baseline Competencies are to be taught as “Introduction” courses, each course should be at least 3 credit hours. The following course number(s) and description should be used:

**Course Name(s):** Introduction to Electrical Technology, Introduction to Electrical Technology I, or Introduction to Electrical Technology II

**Course Abbreviation(s):** ELT 100(3-6), ELT 1013, or ELT 1023

**Classification:** Vocational–Technical Core

**Description:** These courses contain the baseline competencies and suggested objectives from the high school curriculum that directly relate to the community college program. The courses are designed for students entering the community college who have had no previous training or documented experience in the field. (3–6 semester hours based upon existing skills for each student may be divided into two courses for a maximum total of 6 hours of institutional credit.)

**Competencies and Suggested Objectives:**

1. Describe local program and vocational center policies and procedures.
a. Describe local program and vocational center policies and procedures including dress code, attendance, academic requirements, discipline, shop/lab rules and regulations, and transportation regulations.

2. Describe employment opportunities and responsibilities for electricians and related employees.

a. Describe employment opportunities available for electricians, electronics technicians, and electrical related employees including potential earnings, employee benefits, job availability, possible places of employment, working conditions, and educational requirements.

b. Describe basic employee responsibilities including punctuality, physical requirements, customer relations, following directions, job safety, and entry level skills.

3. State procedures of leadership used to reach an agreement in an orderly manner and personal development opportunities provided students in electricity trades by SkillsUSA.

a. State procedures of leadership used in organizational meetings to reach an agreement in an orderly manner including procedures for gaining recognition in a meeting and conducting a SkillsUSA club meeting.

b. Describe the purposes of SkillsUSA including leadership development, personal development, and skills competition.

4. Describe general safety rules for working in a shop/lab and industry.

a. Describe how to avoid on-site accidents.

b. Explain the relationship between housekeeping and safety.

c. Explain the importance of following all safety rules and company safety policies.

d. Explain the importance of reporting all on-the-job injuries, accidents, and near-misses.

e. Explain the need for evacuation policies and the importance of following them.

f. Explain the employer’s substance abuse policy and how it relates to his or her safety.

g. Explain the safety procedures when working near pressurized or high temperature systems.

5. Identify and apply safety around welding operations.

a. Use proper safety practices when welding or working around welding operations.

b. Use proper safety practices when welding in or near trenches and excavations.

c. Explain the term proximity work.

6. Identify and explain use of various barriers and confinements.
a. Explain the safety requirements for working in confined areas.

b. Explain and practice lockout/tagout procedures.

c. Explain the different barriers and barricades and how they are used.

d. Recognize and explain personal protective equipment.

e. Inspect and care for personal protective equipment.

7. Recognize safe lifting and the use of ladders and scaffolds:

a. Identify and explain the procedures for lifting heavy objects.

b. Inspect and safely work with various ladders and scaffolds.

8. Explain the Material Safety Data Sheets (MSDSs).

a. Explain the function of the MSDS.

b. Interpret the requirements of the MSDS.

9. Explain fires.

a. Explain the process by which fires start.

b. Explain fire prevention of various flammable liquids.

c. Explain the classes of fire and the types of extinguishers.

10. Explain safety in and around electrical situations.

a. Explain injuries when electrical contact occurs.

b. Explain safety around electrical hazards.

c. Explain action to take when an electrical shock occurs.

11. Apply basic math skills.

a. Add, subtract, multiply, and divide whole numbers with and without a calculator.

b. Use a standard and a metric rule to measure.

c. Add, subtract, multiply, and divide decimals with and without a calculator.

d. Convert decimals to percents and percents to decimals.

e. Convert fractions to decimals and percents to decimals.
f. Explain what the metric system is and its importance in the electrical trade.

g. Recognize and use metric units of length, weight, volume, and temperature.

12. Identify various hand and power tools used in electrical trades.

a. Identify common hand tools used in electrical trades.

b. Identify common types of power tools used in electrical wiring.

13. Explain the safe use of common hand and power tools used in electrical trades.

a. Explain the reasons for safety in the use of hand and power tools.

b. Explain the procedures for selecting the proper tool for the job.

c. Explain the safe use of each hand and power tool.

14. Explain the procedures for the maintenance of power tools.

a. Explain preventive maintenance.

b. Explain the procedures for the maintenance of power tools.

c. Demonstrate how to perform maintenance of power tools.

15. Describe the terms and scientific principles associated with direct current electricity.

a. Define terms associated with the nature of matter including physical characteristics of matter (elements, compounds, atoms, electrons, protons, and neutrons).

b. Describe laws of electrical charges including like and unlike charges.

c. Identify electrical materials including conductors, insulators, and semiconductors.

d. Describe methods of generating electricity including solar, chemical, mechanical, and thermal.

e. Describe the principles and operation of batteries.

f. Describe basic theories of current flow including electron and conventional flow methods.

g. Describe DC circuit parameters including voltage, power, current, and resistance.

h. Identify resistor types and values using standard resistor color codes and alphanumeric codes.

i. Perform basic engineering notation calculations including conversion, adding, subtracting, multiplying, and dividing.

j. Identify DC circuit schematic symbols.
16. Create circuits and measure DC electricity using the multimeter.
   a. Describe and demonstrate use of a multimeter including measuring voltage, current, and resistance.
   b. Demonstrate use of Ohm’s law to calculate circuit parameters for a series circuit including voltage, current, resistance, and power.
   c. Draw and construct a series circuit with a minimum of three resistances.
   d. Calculate and measure circuit parameters for a series circuit.
   e. Demonstrate use of Ohm’s law to calculate circuit parameters for a parallel circuit including voltage, current, resistance, and power.
   f. Draw and construct a parallel circuit with a minimum of three resistances.
   g. Calculate and measure circuit parameters for a parallel circuit.
   h. Demonstrate use of Ohm’s law to calculate circuit parameters for a series-parallel circuit including voltage, current, resistance, and power.
   i. Draw and construct a series-parallel circuit with a minimum of three resistances.

17. Describe the principles of magnetism and electromagnetic properties.
   a. Describe the principles of magnetism including magnetic fields, polarities, core materials, permeability, motor action, induced current, and associated laws.
   b. Describe the principles of electromagnetic properties including magnetic fields, polarities, core materials, permeability, motor action, induced current, and associated laws.
   c. Construct a simple electromagnet, including use of copper windings and a metal rod.

18. Describe the terms and scientific principles associated with alternating current electricity.
   a. Describe principles of AC generation.
   b. Define terms associated with AC voltage.
   c. Describe sources of AC voltage.
   d. Describe distribution route and components used from power plant to home or business.
   e. Describe the properties and characteristics of inductors.
f. Describe the properties and characteristics of transformers.

g. Describe properties and characteristics of capacitors.

h. Describe differences in phases in electrical power supply.

19. Describe and construct series and parallel circuits.

a. Draw and construct a series resistive circuit, calculating parameters and discussing phase relationship.

b. Draw and construct a parallel resistive circuit, calculating parameters and discussing phase relationship.

c. Draw and construct a series inductive circuit.

d. Draw and construct a parallel inductive circuit.

20. Identify various residential electrical circuits.

a. Diagram various switching circuits to include single pole, three way, and four way.

b. Diagram various receptacles to include 120 and 240 circuits.

c. Diagram low voltage circuits (i.e., doorbells, thermostats).

21. Wire various residential electrical circuits.

a. Wire various switching circuits to include single pole, three way, and four way.

b. Wire various receptacles to include 120 and 240 circuits.

c. Wire low voltage circuits (i.e., doorbells, thermostats).

22. Explain and identify safe rigging and equipment.

a. Explain and practice safe rigging.

b. Identify and explain rigging equipment.

c. Inspect rigging equipment.

23. Identify and explain the use of derricks and cranes.

a. Identify, explain, and perform crane hand signals.

b. Estimate size, weight, and center of gravity.
c. Tie knots.
d. Identify and explain types of derricks.
e. Identify and explain types of cranes.
f. Rig and move materials and equipment.

24. Identify terms and symbols commonly used on blueprints used in electrical trades.
   a. Identify symbols used in residential wiring commonly found on blueprints.
   b. Identify terms used on blueprints.

25. Relate information on prints to real parts and locations.
   a. Interpret electrical symbols to locate various electrical devices.
   b. Interpret an electrical plan to determine layout.
   c. Interpret basic electrical specifications.

26. Identify and apply basic principles of blueprints.
   a. Explain basic layout of a blueprint.
   b. Describe the information in a title block.
   c. Identify the lines used on blueprints.
   d. Explain the architect’s and engineer’s scales.

27. Determine the type and size of conductors/cables used in the electrical trades.
   a. Describe factors that determine the type and size of conductors.
   b. Identify types of cables used in the electrical trades according to National Electrical Code (NEC) and local codes.

28. Determine wiring connections utilizing switching circuits to NEC and local codes.
   a. Perform sound wiring connections including connectors, terminals, and lugs.
   b. Describe functions of switches.

29. Determine grounding requirements according to NEC and local codes.
   a. Perform sound grounding connections as per NEC and/or local codes.
   b. Test grounding system both mechanically and electrically.
30. Determine the types of overcurrent protection devices including fuses, circuit breakers, arc fault interrupters, and ground fault circuit interrupters (GFCI) used in safety switches or load centers.

   a. Describe the types of overcurrent protective devices.
   b. Identify installations that require GFCI protection according to NEC.
   c. Identify types of safety switches and load centers.


   a. Explain the locations of the devices.
   b. Recognize the NEC codes pertaining to the placement of overcurrent protection devices.

32. Determine locations of electrical outlets as shown on the electrical blueprint, according to the NEC.

   a. Identify locations where at least one receptacle is required.
   b. Describe planning techniques when placing boxes on plans.
   c. Explain acceptable heights for boxes in various locations.
   d. Describe the steps in installing boxes in exterior walls to be brick veneered.
   e. Describe the required outlets for various living areas in a residence.

33. Wire electrical devices/loads in accordance with NEC and electrical floor plan.

   a. Install a device box when given cabinet height and wall covering.
   b. Install a ceiling box when given ceiling covering thickness.
   c. Wire a 120-V device or receptacle according to electrical floor plan.
   d. Wire a 240-V device or receptacle according to electrical floor plan.

34. Determine service entrance requirements as per NEC.

   a. Identify parts of a service entrance.
   b. State clearances for service drops in varying situations.
   c. Identify the different types of grounding electrodes.
   d. Describe service requirements for manufactured homes.

35. Install the required service entrance as per NEC.

   a. Explain the location.
b. Describe what material is needed for various service entrances.

c. Install the required entrance.

36. Determine the requirements for electrical trim-out.

a. Explain the grounding requirement for appliances.

b. Describe steps for panel trim-out.

37. Troubleshoot a residence according to the National Electrical Code (NEC).

a. Explain troubleshooting procedures.

b. Troubleshoot an electrical circuit.

38. Demonstrate safe procedures associated with electrical motors in new and existing systems.

a. Perform tag and lock procedures.

b. Select and install proper overload and overcurrent devices according to NEC.

39. Differentiate between types/classes of electrical motors.

a. Explain direct current motor theory of operation including series, shunt, and compound.

b. Explain single-phase motor theory of operation including squirrel cage, capacitor start, capacitor run, shaded pole, and repulsion start-induction run.

c. Explain three-phase motor operation including squirrel cage, synchronous, and wound rotor along with their voltages, amperages, and nameplate data.

40. Determine speed, direction, and control of AC single- and three-phase and DC motors.

a. Reverse rotation of an AC motor, including single-phase and three-phase.

b. Wire multi-voltage single- and three-phase electrical motors.

c. Wire multispeed single- and three-phase electrical motors.

41. Identify the physical and electrical characteristics of electrical motors.

a. Determine physical and electrical characteristics of electrical motors.

b. Determine electrical characteristics using nameplate data and/or NEC requirements.

42. Identify the physical and electrical characteristics of electrical starters.

a. Determine physical characteristics including frame size, shaft, environment, and couplings.
b. Determine electrical characteristics using nameplate data and/or NEC requirements.

43. Wire single- or three-phase electrical motors using manual and automatic controllers/starter with forward/reverse modes.
   a. Wire single-phase manual/automatic controller for speed control and/or direction.
   b. Wire three-phase manual/automatic controller for speed control and/or direction.

44. Describe function of programmable logic controls (PLC).
   a. Define terms associated with programmable logic controls including digital, analog signal, counter, discrete, fiber optics, input, logic, networking, output, programmer, and programmable logic controller.
   b. Explain programmable logic controller functions including input and output signal compared to previously programmed instructions.
   c. Identify input devices for programmable logic controllers including pushbutton switches, limit switches, proximity switches, timers, photoelectric cells, and flow switches.
   d. Identify output devices for programmable logic controllers including motor starters, contractors, solenoids, pilot lights, and coil relays.

45. Describe application of programmable logic controls.
   a. Write a basic PLC program including two and three wire controls.
   b. Wire a PLC input device including pushbutton switches, limit switches, proximity switches, timers, photoelectric cells, and flow switches.
   c. Wire a PLC output device including timers, pilot lights, brakes, solenoids, starter motors, contractors, and coil relays.

46. Demonstrate hand bending procedures.
   a. Identify the methods of hand bending conduit.
   b. Identify the various methods used to install conduit.
   c. Use math to determine conduit bends.
   d. Make different bends by using a hand bender.

47. Identify and install fasteners and anchors.
   a. Identify and explain the use of threaded fasteners.
   b. Identify and explain the use of non-threaded fasteners.
c. Identify and explain the use of various anchors.

d. Install fasteners and anchors.

48. Identify and install various raceways, boxes, and fittings.

a. Identify various types of cable trays and raceways.
b. Identify and select various types and sizes of raceways.
c. Identify and select various types and sizes of cable trays.
d. Identify and select various types of raceway fittings.
e. Describe procedures for installing raceways and boxes on masonry surfaces.
f. Describe procedures for installing raceways and boxes on concrete surfaces.
g. Describe procedures for installing raceways and boxes in a metal stud environment.
h. Follow safety precautions when working with boxes and raceways.

49. Explain, identify, and perform various functions of commercial and industrial wiring.

a. Explain National Electrical Manufacturers Association (NEMA) classifications of switches and enclosures.
b. Explain National Electrical Code (NEC) codes on wiring devices.
c. Identify and state the functions and ratings of various receptacles.
d. Identify and define receptacle terminals and disconnects.
e. Explain Ground Fault Circuit Interrupters (GFCIs).
f. Use a wire stripper to strip a wire.
g. Use a solderless connector to splice wires.
h. Identify and state the functions of limit switches and relays.
i. Identify and state the functions of switchgear.
Appendix A: National Center for Construction Education and Research Standards (2002)³

ELT1.1—Orientation to the Trade
ELT1.2—Electrical Safety
ELT1.3—Introduction to Electrical Circuits
ELT1.4—Electrical Theory
ELT1.5—Introduction to the National Electrical Code
ELT1.6—Device Boxes
ELT1.7—Hand Bending
ELT1.8—Raceways and Fittings
ELT1.9—Conductors and Cables
ELT1.10—Basic Electrical Construction Drawings
ELT1.11—Residential Electric Services
ELT1.12—Electrical Test Equipment

ELT2.1—Alternating Current
ELT2.2—Motors: Theory and Application
ELT2.3—Electric Lighting
ELT2.4—Conduit Bending
ELT2.5—Pull and Junction Boxes
ELT2.6—Conductor Installations
ELT2.7—Cable Tray
ELT2.8—Conductor Terminations and Splices

ELT2.9  Grounding and Bonding
ELT2.10  Circuit Breakers and Fuses
ELT2.11  Control Systems and Fundamental

ELT3.1  Load Calculators – Branch and Feeder Circuits
ELT3.2  Conductor Selection and Calculations
ELT3.3  Practical Applications of Lighting
ELT3.4  Hazardous Locations
ELT3.5  Overcurrent Protection
ELT3.6  Distribution Equipment
ELT3.7  Transformers
ELT3.8  Commercial Services
ELT3.9  Motor Calculations
ELT3.10  Voice, Data, and Video
ELT3.11  Motor Controls

ELT4.1  Load Calculations – Feeders and Services
ELT4.2  Health Care Facilities
ELT4.3  Standby and Emergency Systems
ELT4.4  Basic Electronic Theory
ELT4.5  Fire Alarm Systems
ELT4.6  Specialty Transformers
ELT4.7  Advanced Controls
ELT4.8  HVAC Controls
ELT4.9 Heat Tracing and Freeze Protection

ELT4.10 Motor Operation and Maintenance

ELT4.11 Medium-Voltage Terminations/Splices

ELT4.12 Special Locations

MT.101 Introductory Skills for the Crew Leader

Instrumentation

INS1.1 Hand Tools for Instrumentation

INS1.2 Electrical Safety

INS1.3 Power Tools for Instrumentation

INS1.4 Electrical Systems for Instrumentation

INS1.5 Metallurgy for Instrumentation

INS1.6 Fasteners

INS1.7 Instrumentation Drawings and Documents, Part One

INS1.8 Gaskets and Packing

INS1.9 Lubricants, Sealants, and Cleaners

INS1.10 Flow, Pressure, Level, and Temperature

INS1.11 Tubing

INS1.12 Piping—2 in. and Under

INS1.13 Hoses

INS2.1 Craft-Related Mathematics

INS2.2 Instrumentation Drawings and Documents, Part Two

INS2.3 Principles of Welding for Instrumentation
INS2.4 Process Control Theory
INS2.5 Detectors, Secondary Elements, Transducers, and Transmitters
INS2.6 Controllers, Recorders, and Indicators
INS2.7 Control Valves, Actuators, and Positioners
INS2.8 Relays and Timers
INS2.9 Switches and Photoelectric Devices
INS2.10 Filters, Regulators, and Dryers
INS2.11 Analyzers and Monitors
INS2.12 Panel-Mounted Instruments
INS2.13 Installing Field-Mounted Instruments
INS2.14 Raceways for Instrumentation

Industrial Maintenance: Electrical and Instrumentation

IMM3.1 Hazardous Locations
IMM3.2 Electronic Components
IMM3.3 E & I Drawings
IMM3.4 Motor Controls
IMM3.5 Distribution Equipment
IMM3.6 Transformers
IMM3.7 Conductor Selection and Calculation
IMM3.8 Temporary Grounding
IMM3.9 Commercial and Industrial Electrical Services
IMM3.10 Pipe Layout and Installation
IMM3.11 Machine Bending of Conduit
IMM3.12 Hydraulic and Pneumatic Controls
IMM3.13 Motor-Operated Valves

Electronic Systems Technician

EST1.1 Introduction to the Trade
EST1.2 Construction Materials and Methods
EST1.3 Pathways and Spaces
EST1.4 Fasteners and Anchors
EST1.5 Job-Site Safety
EST1.6 Craft-Related Mathematics
EST1.7 Hand Bending of Conduit
EST1.8 Low-Voltage Cabling

EST2.1 DC Circuits
EST2.2 AC Circuits
EST2.3 Semiconductors and Integrated Circuits
EST2.4 Basic Test Equipment
EST2.5 Power Quality and Grounding
EST2.6 Introduction to Electrical Blueprints
EST2.7 Switching Devices and Timers
EST2.8 Wire and Cable Terminations
EST2.9 Introduction to Codes and Standards
EST2.10 Computer Applications
EST2.11 Advanced Test Equipment
EST3.1 Cable Selection
EST3.2 Buses and Networks
EST3.3 Fiber Optics
EST3.4 Video Systems
EST3.5 Wireless Communication
EST3.6 Site Survey, Project Planning, and Documentation
EST3.7 Maintenance and Repair
MT101 Introductory Skills for the Crew Leader
EST3.9 Rack Systems

EST4.1 Fire Alarm Systems
EST4.2 Intrusion Detection Systems
EST4.3 Audio Systems
EST4.4 Overview of Nurse Call and Signaling Systems
EST4.5 CCTV Systems
EST4.6 Broadband Systems
EST4.7 Access Control Systems
EST4.8 Systems Integration
EST4.9 Systems Commissioning and User Training
EST4.10 Media Management Systems
EST4.11 Telecommunications Systems
Appendix B: Related Academic Standards

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Reading
R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause–/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)

Mathematics Computation
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations

Applied Mathematics
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)

Language
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)

Spelling
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)
## Appendix C: 21st Century Skills

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**CS1  Global Awareness**
1. Using 21st century skills to understand and address global issues
2. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
3. Promoting the study of non-English language as a tool for understanding other nations and cultures, including the use of non-English languages

**CS2  Financial, Economic, and Business and Entrepreneurial Literacy**
1. Knowing how to make appropriate personal economic choices
2. Understanding the role of the economy and the role of business in society
   - Applying appropriate 21st century skills to function as a productive contributor within an organizational setting
   - Integrating oneself within and adapting continually to our nation’s evolving economic and business environment
3. Using entrepreneurial skills to enhance workplace productivity and career options
CS3 Civic Literacy
- Being an informed citizen to participate effectively in government
  1. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
  1-2. Exercising the rights and obligations of citizenship at local, state, national, and global levels
  2-3. Understanding the local and global implications of civic decisions
- Applying 21st century skills to make intelligent choices as a citizen

CS4 Information Health Literacy
Obtaining, interpreting and Communication Skills
- Information and media literacy skills: Analyzing, accessing, managing, integrating, evaluating, and creating information in a variety of forms and media; understanding the role of media in society
- Communication skills: Understanding, managing, and creating effective oral, written, and multimedia communication in a variety of forms and contexts

CS5 Thinking and Problem-Solving Skills
- Critical thinking and systems thinking: Exercising sound reasoning in understanding and making complex choices and understanding the interconnections among systems
- Problem identification, formulation, and solution: Ability to frame, analyze, and solve problems
- Creativity and intellectual curiosity: Developing, implementing, and communicating new ideas to others and staying open and responsive to new and diverse perspectives

CS6 Interpersonal and Self-Directional Skills
- Interpersonal and collaborative skills: Demonstrating teamwork and leadership, adapting to varied roles and responsibilities, working productively with others, exercising empathy, and respecting diverse perspectives
- Self-direction: Monitoring one's own understanding and learning needs, locating appropriate resources, and transferring learning from one domain to another
- Accountability and adaptability: Exercising personal responsibility and flexibility in personal, workplace, and community contexts; setting and meeting high standards and goals for one’s self and others; tolerating ambiguity
- Social responsibility: Acting responsibly with the interests of the larger community in mind; demonstrating ethical behavior in personal, workplace, and community contexts
Appendix D: National Educational Technology Standards for Students

T1 Basic operations and concepts

- Students demonstrate a sound understanding of the nature and operation of technology systems.
- Students are proficient in the use of technology.

T2 Social, ethical, and human issues

- Students understand the ethical, cultural, and societal issues related to technology.
- Students practice responsible use of technology systems, basic health information and services and using such information, and software.
- Students develop positive attitudes toward technology use services in ways that support lifelong learning, collaboration, personal pursuits, and productivity.

T3 Technology productivity tools

1. Students use technology tools to enhance learning, increase productivity, and promote creativity.

2. Students use productivity tools to collaborate in constructing technology-enhanced models, to prepare publications, and to produce other creative works.

T4 Technology communications tools

- Students use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences.

2. Students use a variety of media and formats to communicate. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction.

- Using available information and ideas effectively to multiple audiences.

T5 Technology research tools

- Students use technology to locate, evaluate, and collect information from a variety of sources.

- Students use technology tools to process data and report results.

- Students evaluate and select new information resources and technological innovations based on the appropriateness for specific tasks.

T6 Technology problem-solving and decision-making tools

2.3. Students use technology resources for solving problems and making informed decisions.

4. Students employ technology in the development of strategies for solving problems in the real world. Establishing and monitoring personal and family health goals.

5. Understanding national and international public health and safety issues.

CS5 Environmental Literacy

1. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water and ecosystems
2. Demonstrate knowledge and understanding of society’s impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
3. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
4. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

**CS6 Creativity and Innovation**
1. Think Creatively
2. Work Creatively with Others
3. Implement Innovations

**CS7 Critical Thinking and Problem Solving**
1. Reason Effectively
2. Use Systems Thinking
3. Make Judgments and Decisions
4. Solve Problems

**CS8 Communication and Collaboration**
1. Communicate Clearly
2. Collaborate with Others

**CS9 Information Literacy**
1. Access and Evaluate Information
2. Use and Manage Information

**CS10 Media Literacy**
1. Analyze Media
2. Create Media Products

**CS11 ICT Literacy**
1. Apply Technology Effectively

**CS12 Flexibility and Adaptability**
1. Adapt to change
2. Be Flexible

**CS13 Initiative and Self-Direction**
1. Manage Goals and Time
2. Work Independently
3. Be Self-directed Learners

**CS14 Social and Cross-Cultural Skills**
1. Interact Effectively with others
2. Work Effectively in Diverse Teams

**CS15 Productivity and Accountability**
1. Manage Projects
2. Produce Results

**CS16 Leadership and Responsibility**
1. Guide and Lead Others
2. Be Responsible to Others
2012 Mississippi Curriculum Framework

Postsecondary Electrical Technology
(Program CIP: 46.0302 – Electrician)

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Published by

Office of Career and Technical Education
Mississippi Department of Education
Jackson, MS 39205

Research and Curriculum Unit
Mississippi State University
Mississippi State, MS 39762

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|---------------------------|-------------------------------------------------------------------|
Preface

Electrical Technology Research Synopsis

Articles, books, websites, and other materials listed at the end of each course were considered during the revision process. Specific journals, articles, and resources were especially useful in providing insight into trends and issues in the field. These references are suggested for use by instructors and students during the study of the topics outlined.

Industry advisory team members from colleges throughout the state were asked to give input related to changes to be made to the curriculum framework. Specific comments related to soft skills needed in this program included positive attitude, dependability, team player, flexibility, punctuality, good work ethic, initiative, and communication. Occupational-specific skills stated included computer use, math and estimating, blueprint reading, NEC and local codes, circuits, and motor controls. Safety practices emphasized included adhering to standard precautions and following OSHA guidelines.

Instructors from colleges throughout the state were also asked to give input on changes to be made to the curriculum framework. Specific comments related to this program included statements from Advisory Committee members to increase productivity and work ethics. Changes suggested for the curriculum included improving math skills, reading schematics, and safety practices. Introduction to Construction Technology (ELT 1173) was added as an elective.

Needs of the Future Workforce

The electrical occupation in Mississippi (16%) is projected to grow faster than average in the United States (10%) (EMSI, 2011). However, the median hourly earnings indicate that Mississippi electrical workers earn less than the national median wage earnings.

Electrical Technology Employment Projections and Earnings

<table>
<thead>
<tr>
<th>Region</th>
<th>2011 Jobs</th>
<th>2021 Jobs</th>
<th>Change</th>
<th>% Change</th>
<th>Openings</th>
<th>2011 Median Hourly Earnings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional Total</td>
<td>30,105</td>
<td>35,034</td>
<td>4,929</td>
<td>16%</td>
<td>11,215</td>
<td>$14.50</td>
</tr>
<tr>
<td>National Total</td>
<td>2,961,370</td>
<td>3,245,703</td>
<td>284,333</td>
<td>10%</td>
<td>907,473</td>
<td>$17.41</td>
</tr>
</tbody>
</table>

Curriculum

The following national standards were referenced in each course of the curriculum:

- NCCER 2008 Electrical Level One and Two Modules
- CTB/McGraw-Hill LLC Tests of Adult Basic Education, forms 9 and 10 Academic Standards
- 21st Century Skills

Industry and instructor comments, along with current research, were considered by the curriculum revision team during the revision process, and changes were made as needed and appropriate. Many of the skills and topics noted in the research were already included in the curriculum framework. Specific changes made to the curriculum at the curriculum revision meeting included the following:
Add new courses:
CTE 1163 Introduction to Sustainable and Renewable Energy
CTE 1153 Computational Methods for Career and Technical Education
CTE 1143 Fundamentals of Construction and Manufacturing

- Competencies and objectives were reviewed to ensure accuracy and appropriateness.
- Clarification to content that relates to the Contren Best Practices were made.
- The Recommended Tools and Equipment list was updated to reflect the tool list for successful completion of Electrical Technology theory and content.

Assessment

Students will be assessed using the MS-CPAS2 Assessment, unless an alternative assessment is approved.

Students are assessed using the Electrical Technology MS-CPAS2 test. The MS-CPAS2 blueprint can be found at [http://www.rcu.msstate.edu/](http://www.rcu.msstate.edu/).

  a. A student’s technical skill attainment for completion of the Career Certificate will be assessed utilizing the MSCPAS Career Certificate (Y1) assessment score.
  b. A student’s technical skill attainment for the Technical Certificate and/or the Associate of Applied Science degree will be assessed utilizing the student’s MSCPAS Career Certificate (Y1) assessment and MSCPAS Technical Certificate (Y2) assessment.
  c. Timing of Y1 and Y2 Assessments:
     a. A student may complete the Y1 assessment upon application for the Career Certificate.
     b. A student may complete the Y2 assessment upon application for the Technical Certificate or the Associate of Applied Science Degree (scores for the Y1 and Y2 assessments are averaged.)
     c. A student may complete both the Y1 and the Y2 assessment upon application for the Technical Certificate or the Associate of Applied Science Degree (scores for the Y1 and Y2 assessments are averaged.

If there are questions regarding assessment of this program, please contact the Instructional Design Specialist at the Research and Curriculum Unit at 662.325.2510.

Professional Learning

It is suggested that instructors participate in professional learning related to the following concepts:

- How to use the program Blackboard
- Differentiated instruction – To learn more about differentiated instruction, please go to [http://www.paec.org/teacher2teacher/additional_subjects.html](http://www.paec.org/teacher2teacher/additional_subjects.html) and click on Differentiated Instruction. Work through this online course and review the additional resources.
• Related Academics – To learn more about Related Academics, please go to [http://www.ctb.com/ctb.com/control/main?p=home](http://www.ctb.com/ctb.com/control/main?p=home) and click on the TABE logo to learn about the most updated standards of the TABE exam.

**Program Exceptions**

No program exceptions exist at this time.

**Articulation**

Articulation credit from Secondary Construction – Electrical Career Pathway to Postsecondary Electrical Technology is available upon implementation of this curriculum by the college. Secondary students who have completed the articulated 2-year Secondary Construction – Electrician Career Pathway Courses may be awarded articulated college credit according to Mississippi Community College Board (MCCB) guidelines.

<table>
<thead>
<tr>
<th>Articulated Secondary Course</th>
<th>Articulated Postsecondary Course</th>
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<tr>
<td>S Electrician and Industrial Maintenance (CIP 46.0302)</td>
<td>ELT 1192 – 3 Fundamentals of Electricity</td>
</tr>
</tbody>
</table>

**Statewide Guidelines on Articulated Credit**

*Eligibility*

- **To be eligible for articulated credit, a student must:**
  - Complete the articulated Secondary Career and Technical Education Program
  - Score an 80 percent or higher on the Mississippi Career Planning and Assessment System (MS-CPAS2) in their secondary program of study

- **To be awarded articulated credit, a student must:**
  - Enroll in the community or junior college within 18 months of graduation
  - Articulated courses are transcribed immediately upon enrollment at a community college

**How MS-CPAS2 will be documented**

- The Research and Curriculum Unit of Mississippi State University will provide MS-CPAS2 scores, CIP Codes, district codes, secondary pathway name, and college numbers (identified by each student as colleges of interest) to Mississippi Department of Education to place on student transcripts.
- The Research and Curriculum Unit of Mississippi State University will provide MS-CPAS2 scores, CIP Codes, district codes and college number to the MCCB.
- The MCCB will forward the list of students eligible for articulated credit to the colleges.
Transcripting of Articulated Credit

- Articulated credit will be transcripted immediately upon college enrollment
- No grade will be given on the transcript for articulated courses, only hours granted will be transcripted (thus resulting in no change in quality points)

Time Limit

- MS-CPAS2 scores will be accepted to demonstrate competencies for up to 18 months after high school graduation

Cost

- No costs will be assessed on hours earned through articulated credit

Mississippi Workforce Advantage

The primary purpose of Career and Technical Education (CTE) and Workforce Education (WE) is to prepare present and future workers for high-wage, high-skill, and high-demand occupations in current or emerging professions. Additionally, CTE and WE programs aim to offer Mississippians opportunities that correspond to labor-market demands with multiple entrance and exit requirements that result in portable and stackable credentials for industry, certification-based training and coursework. A stackable credential is a career or college certificate program that builds, or “stacks,” with other certificate programs with the purpose of reengaging adults in school in order to prepare them for college and “next step”-level employment.

Through this collaborative initiative, CTE and WE curricula are developed in credit-bearing course hours and in WE modules to provide statewide standards for awarding college credit for technical, industry-recognized certificates. The designated WE curriculum module’s content articulates a specific number of college credits and aligns to all credit-bearing course competencies.

A secondary goal of MS Workforce Advantage is to increase student and participant enrollment, participation, and completion of credit-bearing programs. Strategies to promote transition to and success within the credit-bearing program are essential to the goal of helping students earn credentials, certificates, and degrees. Ongoing professional development for all stakeholders will be offered to ensure success.

A copy of the CTE to WE curriculum modules is located on the RCU website at

http://www.rcu.msstate.edu/MCCB.aspx
Foreword

As the world economy continues to evolve, businesses and industries must adopt new practices and processes in order to survive. Quality and cost control, work teams and participatory management, and an infusion of technology are transforming the way people work and do business. Employees are now expected to read, write, and communicate effectively; think creatively, solve problems, and make decisions; and interact with each other and the technologies in the workplace. Career–technical programs must also adopt these practices in order to provide graduates who can enter and advance in the changing work world.

The curriculum framework in this document reflects these changes in the workplace and a number of other factors that impact local career–technical programs. Federal and state legislation calls for articulation between high school and community college programs, integration of academic and career skills, and the development of sequential courses of study that provide students with the optimum educational path for achieving successful employment. National skills standards, developed by industry groups and sponsored by the U.S. Department of Education and Labor, provide career and technical educators with the expectations of employers across the United States. All of these factors are reflected in the framework found in this document.

Referenced throughout the courses of the curriculum are the 21st Century Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. Another important aspect of learning and working in the 21st century involves technology skills. The International Society for Technology in Education, developer of the National Educational Technology Standards (NETS), was a strategic partner in the Partnership for 21st Century Skills.

Each postsecondary program of instruction consists of a program description and a suggested sequence of courses that focus on the development of occupational competencies. The MS-CPAS2 blueprints are based upon the suggested course sequences to allow for Career Certificate (Y1) and Technical Certificate (Y2) assessments for all exit options. Please refer to the blueprint online. Each career–technical course in this sequence has been written using a common format, which includes the following components:

- **Course Name** – A common name that will be used by all community and junior colleges in reporting students
- **Course Abbreviation** – A common abbreviation that will be used by all community and junior colleges in reporting students
- **Classification** – Courses may be classified as the following:
Career–technical core – A required career–technical course for all students
Area of concentration (AOC) core – A course required in an area of concentration of a cluster of programs
Career–technical elective – An elective career–technical course
Related academic course – An academic course that provides academic skills and knowledge directly related to the program area
Academic core – An academic course that is required as part of the requirements for an associate’s degree

- Description – A short narrative that includes the major purpose(s) of the course and the recommended number of hours of lecture and laboratory activities to be conducted each week during a regular semester
- Prerequisites – A listing of any courses that must be taken prior to or on enrollment in the course
- Corequisites – A listing of courses that may be taken while enrolled in the course
- Competencies and Suggested Objectives – A listing of the competencies (major concepts and performances) and the suggested student objectives that will enable students to demonstrate mastery of these competencies

The following guidelines were used in developing the program(s) in this document and should be considered in compiling and revising course syllabi and daily lesson plans at the local level:

- The content of the courses in this document reflects approximately 75% of the time allocated to each course. The remaining 25% of each course should be developed at the local district level and may reflect the following:
  - Additional competencies and objectives within the course related to topics not found in the state framework, including activities related to specific needs of industries in the community college district
  - Activities that develop a higher level of mastery on the existing competencies and suggested objectives
  - Activities and instruction related to new technologies and concepts that were not prevalent at the time the current framework was developed or revised
  - Activities that include integration of academic and career–technical skills and course work, school-to-work transition activities, and articulation of secondary and postsecondary career–technical programs
  - Individualized learning activities, including work-site learning activities, to better prepare individuals in the courses for their chosen occupational areas

- Sequencing of the course within a program is left to the discretion of the local district. Naturally, foundation courses related to topics such as safety, tool and equipment usage, and other fundamental skills should be taught first. Other courses related to specific skill areas and related academics, however, may be sequenced to take advantage of seasonal and climatic conditions, resources located outside of the school, and other factors. Programs that offer an Associate of Applied Science Degree must include all of the required Career Certificate
courses, Technical Certificate courses AND a minimum of 15 semester hours of General Education Core Courses. The courses in the General Education Core may be spaced out over the entire length of the program so that students complete some academic and Career Technical courses each semester. Each community college specifies the actual courses that are required to meet the General Education Core Requirements for the Associate of Applied Science Degree at their college. The following 2012 SACS standard applies.

- Section 2.7.3 For degree completion in associate programs, the component constitutes a minimum of 15 semester hours or the equivalent. These credit hours are to be drawn from and include at least one course from each of the following areas: humanities/fine arts, social/behavioral sciences, and natural science/mathematics.

In order to provide flexibility within the districts, individual courses within a framework may be customized by doing the following:

- Adding new competencies and suggested objectives to complement the existing competencies and suggested objectives in the program framework.
- Revising or extending the suggested objectives for individual competencies
- Adjusting the semester credit hours of a course to be up 1 hour or down 1 hour (after informing the Mississippi Community College Board [MCCB] of the change)

In addition, the curriculum framework as a whole may be customized by doing the following:

- Sequencing courses within the suggested course sequence reflecting the new assessment format
- Developing and adding a new course that meets specific needs of industries and other clients in the community or junior college district (with MCCB approval)
- Adding courses listed in the “Approved Career and Technical Electives List” as local certificate and degree completion requirements to meet specific needs of industries and other clients in the community. The “Approved Career and Technical Electives” are currently approved in the Uniform Course Numbering Book; therefore, MCCB approval is not required.
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Program Description

The Postsecondary Electrical Technology program prepares individuals to install, operate, maintain, and repair electrical systems. These systems include residential, commercial, and industrial wiring, motors controls, and electrical distribution panels. The program offers extensive hands-on training in electrical troubleshooting and the development of problem-solving skills in industrial electrical procedures, programmable logic controllers, and process control.

Program Requirements

Electrical Technology is an articulated career and technical program designed to provide its students with technical skills. The technical program consists of essential skills that may be obtained in a secondary program or at the community/junior college level and technical skills and academics that must be obtained at the community/junior college level.

This curriculum in Electrical Technology was developed using the competencies and objectives as developed by the National Center for Construction Education and Research (NCCER). Also, the National Electrical Code was used to ensure compliance with applicable codes.

The listing of tasks served as a baseline for the revision of this curriculum. The task list used in this curriculum is based upon the following assumptions:

1. In all areas, appropriate theory, safety, and support instruction will be provided for each task. It is essential that all instruction has included use of appropriate tools, testing, and measuring instruments needed to accomplish certain tasks. It is also assumed that each student has received instruction to locate and use current reference materials from industry publications that present manufacturers’ recommended or required specifications and procedures for doing the various tasks.

2. The individual program should have written and detailed evaluation standards for each task covered in the curriculum. Learning progress of students should be monitored and evaluated against these stated standards. A system should be in place that informs all students of their progress throughout the program.

3. It is recognized that individual courses will differ across the technical programs. The development of appropriate learning activities and tests will be the responsibility of the individual program.

4. These standards require that tasks contained in the list be included in the program to validate that the program is meeting the needs of the electrical industry.
The curriculum for Electrical Technology is designed to serve as the core curriculum for
approximately 75% of each course at the postsecondary level. The remaining 25% of each course
is to be added at the local level based upon needs of students and area employers.

The Electrical Technology program offers a Career certificate, Technical certificate and/or an
Associate of Applied Science Degree.
# Suggested Course Sequence

## Electrical Technology

### Career Certificate Option

A Career Certificate will be awarded upon completion of the required courses for the Career Certificate option in Electrical Technology.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>*ELT 1113</td>
<td>Residential/Light Commercial Wiring</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
</tr>
<tr>
<td>*ELT 1123</td>
<td>Commercial and Industrial Wiring</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
</tr>
<tr>
<td>*ELT 1144+</td>
<td>AC and DC Circuits for Electrical Technology</td>
<td>4 sch: 2 hr lecture, 4 hr lab</td>
</tr>
<tr>
<td>*ELT 1192–3</td>
<td>Fundamentals of Electricity</td>
<td>2-3 sch: 1 hr lecture, 2 hr lab</td>
</tr>
<tr>
<td>*ELT 1213</td>
<td>Electrical Power</td>
<td>3 sch: 2 hr. lecture, 2 hr. lab</td>
</tr>
<tr>
<td>*ELT 1253</td>
<td>Branch Circuit and Service Entrance Calculations</td>
<td>3 sch: 2 hr lecture, 2 hr. lab</td>
</tr>
<tr>
<td>*ELT 1263</td>
<td>Blueprint Reading/Planning in Residential Installation</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
</tr>
<tr>
<td>*ELT 1413</td>
<td>Motor Control Systems</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
</tr>
<tr>
<td></td>
<td>Approved Career Technical Electives</td>
<td>5-6 sch</td>
</tr>
</tbody>
</table>

**Total Semester Credit Hours for a Career Certificate**: 30 sch

* DC Circuits (EET 1114) and AC Circuits (EET 1123) may be taken instead of AC and DC Circuits for Electrical Technology (ELT 1144) and the 3 hour elective.

*These course competencies will be assessed in the MSCPAS2 Career certificate (Y1) assessment.*

Students who lack entry level skills in math, English, science, etc. will be provided related studies.
Suggested Course Sequence  
Electrical Technology  

Technical Certificate Option

A Technical Certificate will be awarded upon completion of all required Career Certificate courses AND the following required Technical Certificate courses in the Electrical Technology program.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>*ELT 2113-4</td>
<td>Equipment Maintenance, Troubleshooting, and Repair</td>
<td>3-4 sch: 1 hr lecture, 4-6 hr lab</td>
</tr>
<tr>
<td>*ELT 2424</td>
<td>Solid State Motor Control</td>
<td>4 sch: 2 hr lecture, 4 hr lab</td>
</tr>
<tr>
<td>*ELT 2613</td>
<td>Programmable Logic Controllers</td>
<td>3 sch: 1 hr. lecture, 4 hr. lab</td>
</tr>
<tr>
<td></td>
<td>Approved Career Technical Electives</td>
<td>4-5 sch</td>
</tr>
<tr>
<td></td>
<td>Total Semester Credit Hours for a Technical Certificate</td>
<td>45 sch</td>
</tr>
</tbody>
</table>

*These course competencies will be assessed in the MSCPAS2 Technical certificate (Y2) assessment.
Suggested Course Sequence
Electrical Technology

Associate of Applied Science Degree Option

To receive the Associate of Applied Science Degree in Electrical Technology, a student must complete all of the required Career Certificate courses, Technical Certificate courses AND a minimum of 15 semester hours of General Education Core Courses. The courses in the General Education Core may be spaced out over the entire length of the program so that students complete some academic and Career Technical courses each semester. Each community college specifies the actual courses that are required to meet the General Education Core Requirements for the Associate of Applied Science Degree at their college. The following 2012 SACS standard applies.

Section 2.7.3 For degree completion in associate programs, the component constitutes a minimum of 15 semester hours or the equivalent. These credit hours are to be drawn from and include at least one course from each of the following areas: humanities/fine arts, social/behavioral sciences, and natural science/mathematics.

A student must complete the following minimum credit requirements for the AAS Degree Option:

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Minimum Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Career Certificate</td>
<td>30 credits minimum</td>
</tr>
<tr>
<td>Technical Certificate</td>
<td>15 credits minimum</td>
</tr>
<tr>
<td>General Education Core Courses</td>
<td>15 credits minimum</td>
</tr>
<tr>
<td>Total Semester Credit Hours for the Associate of Applied Science Degree</td>
<td>60 credits minimum hours earned as a compilation of Career, Technical, and Academic credit hours.</td>
</tr>
</tbody>
</table>

Approved Career–Technical elective courses have been included to allow community colleges and students to customize programs to meet the needs of industries and employers in their area.

In order to provide flexibility within the districts, individual courses within a framework may be customized by doing the following:

- Adding new competencies and suggested objectives to complement the existing competencies and suggested objectives in the program framework.
- Revising or extending the suggested objectives for individual competencies
- Adjusting the semester credit hours of a course to be up 1 hour or down 1 hour (after informing the Mississippi Community College Board [MCCB] of the change)

In addition, the curriculum framework as a whole may be customized by doing the following:

- Sequencing courses within the suggested course sequence to reflecting the new assessment format
- Developing and adding a new course that meets specific needs of industries and other clients in the community or junior college district (with MCCB approval)
• Adding courses listed in the “Approved Career and Technical Electives List” as local certificate and degree completion requirements to meet specific needs of industries and other clients in the community. The “Approved Career and Technical Electives” are currently approved in the Uniform Course Numbering Book; therefore, MCCB approval is not required.
## APPROVED CAREER AND TECHNICAL ELECTIVES for Electrical Technology

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPT 1113</td>
<td>Fundamentals of Microcomputer Applications†</td>
<td>3 sch</td>
<td>See Appropriate Program Description</td>
</tr>
<tr>
<td>CTE 1143</td>
<td>Fundamentals of Construction and Manufacturing</td>
<td>(3 sch: 2 hr lecture, 2 hr lab)</td>
<td></td>
</tr>
<tr>
<td>CTE 1153</td>
<td>Computational Methods for Career and Technical Education</td>
<td>(3 sch: 2-hr lecture, 2-hr lab)</td>
<td></td>
</tr>
<tr>
<td>CTE 1163</td>
<td>Introduction to Sustainable and Renewable Energy</td>
<td>(3 sch: 2-hr lecture, 2-hr lab)</td>
<td></td>
</tr>
<tr>
<td>EET 1214</td>
<td>Digital Electronics</td>
<td>3 sch</td>
<td>See Appropriate Program Description</td>
</tr>
<tr>
<td>EET 1334</td>
<td>Solid State Devices and Circuits</td>
<td>3 sch</td>
<td>See Appropriate Program Description</td>
</tr>
<tr>
<td>EET 1613</td>
<td>Computer Fundamentals for Electronics/Electricity†</td>
<td>3 sch</td>
<td>See Appropriate Program Description</td>
</tr>
<tr>
<td>EET 2423</td>
<td>Fundamentals of Fiber Optics</td>
<td>3 sch</td>
<td>See Appropriate Program Description</td>
</tr>
<tr>
<td>ELT 1133</td>
<td>Introduction to the National Electric Code</td>
<td>3 sch</td>
<td>2 hr lecture, 2 hr lab</td>
</tr>
<tr>
<td>ELT 1153</td>
<td>Computational Methods for Electrical Technology</td>
<td>3 sch</td>
<td>2 hr lecture, 2 hr lab</td>
</tr>
<tr>
<td>ELT 1163</td>
<td>Drafting for Electrical Technology</td>
<td>3 sch</td>
<td>1 hr lecture, 4 hr lab</td>
</tr>
<tr>
<td>ELT 1223</td>
<td>Motor Maintenance and Troubleshooting</td>
<td>3 sch</td>
<td>2 hr lecture, 2 hr lab</td>
</tr>
<tr>
<td>ELT 1253</td>
<td>Branch Circuit and Service Entrance Calculations</td>
<td>3 sch</td>
<td>2 hr lecture, 2 hr lab</td>
</tr>
<tr>
<td>ELT 1263</td>
<td>Blueprint Reading/Planning in Residential Installation</td>
<td>3 sch</td>
<td>2 hr lecture, 2 hr lab</td>
</tr>
<tr>
<td>ELT 1273</td>
<td>Switching Circuits for Residential, Commercial, and Industrial Applications</td>
<td>3 sch</td>
<td>2 hr lecture, 2 hr lab</td>
</tr>
<tr>
<td>ELT 1283</td>
<td>Estimating the Cost of a Residential Installation</td>
<td>3 sch</td>
<td>2 hr lecture, 2 hr lab</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Credits: Hours</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>------------------------------------------------------------------------------</td>
<td>----------------</td>
<td></td>
</tr>
<tr>
<td>ELT 1313</td>
<td>Automated Manufacturing Control for Electricity</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 1324</td>
<td>Calibration and Measurement Principles used in the Electrical Industry</td>
<td>4 sch: 3 hr lecture, 2 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 1334</td>
<td>Flexible Manufacturing Systems for Electrical Technology</td>
<td>4 sch: 2 hr lecture, 4 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 1343</td>
<td>Fundamentals of Instrumentation</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 1353</td>
<td>Fundamentals of Robotics for Electrical Technology</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 1363</td>
<td>Industrial Hydraulics for Electrical Technology</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 1373</td>
<td>Industrial Pneumatics for Electrical Technology</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 1383</td>
<td>Industrial Robotics for Electrical Technology</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 1393</td>
<td>Servo Control Systems for Electrical Technology</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 1434</td>
<td>Solid State Devices and Circuits for Electrical Technology</td>
<td>4 sch: 2 hr lecture, 4 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 1513</td>
<td>Data Acquisition and Communications</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 1523</td>
<td>Fundamentals of Fiber Optics for Electrical Technology</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 1533</td>
<td>Fundamentals of Data Communications for Electrical Technology</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 1544</td>
<td>Network Systems for Electrical Technology</td>
<td>4 sch: 2 hr lecture, 4 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 1553</td>
<td>Satellite Systems</td>
<td>3 sch: 1 hr lecture, 4 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 1564</td>
<td>Telephone Systems for Special Systems Electrical Technology</td>
<td>4 sch: 3 hr lecture, 2 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 1614</td>
<td>Principles of Hydraulics and Pneumatics</td>
<td>3-4 sch: 1 hr lecture, 4-6 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 2113-4</td>
<td>Equipment Maintenance, Troubleshooting, and Repair</td>
<td>3-4 sch: 1 hr lecture, 4-6 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 2213</td>
<td>Introduction to Sustainable and Renewable Energy</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
<td></td>
</tr>
<tr>
<td>ELT 2613</td>
<td>Programmable Logic Controllers</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
<td></td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Credits and Hours</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
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<td></td>
</tr>
<tr>
<td>ELT 2623</td>
<td>Advanced Programmable Logic Controllers</td>
<td>3 sch: 2 hr lecture, 2 hr lab</td>
<td></td>
</tr>
<tr>
<td>IMM 1933</td>
<td>Manufacturing Skills</td>
<td>3 sch: See Appropriate Program Description</td>
<td></td>
</tr>
<tr>
<td>ELT 291(1–3)</td>
<td>Special Project I</td>
<td>3 sch: 2–6 hr. lab</td>
<td></td>
</tr>
<tr>
<td>ELT 293(1–3)</td>
<td>Special Project II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELT 292(1–6)</td>
<td>Supervised Work Experience I</td>
<td>1-6 sch: 3-18 hr. externship</td>
<td></td>
</tr>
<tr>
<td>ELT 294(1–6)</td>
<td>Supervised Work Experience II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WBL 191(1-3)</td>
<td>Work-Based Learning</td>
<td>1-3 sch: 3-9 hr. externship</td>
<td></td>
</tr>
<tr>
<td>WBL 192(1-3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WBL 193(1-3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WBL 291(1-3)</td>
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<td></td>
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</tr>
<tr>
<td>WBL 292(1-3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WBL 293(1-3)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Other instructor approved electives that are listed in the MCCB approved CTE or Academic Uniform Course Numbering document.*
Electrical Technology Courses

Course Name: Residential/Light Commercial Wiring

Course Abbreviation: ELT 1113

Classification: Career, Technical, and Associate Degree Core

Description: Advanced skills related to the wiring of multifamily and small commercial buildings. Includes instruction and practice in service-entrance installation, specialized circuits, and the use of commercial raceways (3 sch: 2-hr lecture, 2-hr lab).

Prerequisite: Fundamentals of Electricity (ELT 1192-3) or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Read and utilize drawings of a structure.</td>
</tr>
<tr>
<td>a. Identify residential and commercial symbols used on drawings.</td>
</tr>
<tr>
<td>b. Calculate feeder lead for single, multifamily, and small commercial buildings.</td>
</tr>
<tr>
<td>c. Select the proper size and type of wire, conduit, fittings, load protection devices, and boxes for residential and commercial installation.</td>
</tr>
<tr>
<td>d. Develop a cost estimate for an assigned project to include supply and labor costs.</td>
</tr>
<tr>
<td>e. Interpret a residential/commercial drawing and specifications to determine tools, equipment, and supplies needed for the job.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Simulate wiring a residence and/or commercial building according to the current NEC and local codes.</td>
</tr>
<tr>
<td>a. Draw a sketch, and install a service entrance and load, center, main branch circuits, feeder circuits, appliance circuits, and various switching circuits, according to current NEC and local codes.</td>
</tr>
<tr>
<td>b. Draw a sketch, and install specialized circuits to include telephone, low voltage, and remote control systems.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Discuss current protective devices, load centers, panel boards, and safety switches.</td>
</tr>
<tr>
<td>a. List five types of over current protective devices and their characteristics.</td>
</tr>
<tr>
<td>b. List installations that require AFCI/GFCI circuits.</td>
</tr>
<tr>
<td>c. Identify types of safety enclosures and configurations.</td>
</tr>
<tr>
<td>d. Draw and label parts of a breaker load center.</td>
</tr>
<tr>
<td>e. Demonstrate safety rules for working near or at load centers, panel boards, and safety switches by use of lockout/tagout procedures.</td>
</tr>
</tbody>
</table>
### National Center for Construction Education and Research Standards

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELT1.6</td>
<td>Device Boxes (Module 26106.11)</td>
<td></td>
</tr>
<tr>
<td>ELT1.9</td>
<td>Conductors and Cables (Module 26109-11)</td>
<td></td>
</tr>
<tr>
<td>ELT1.10</td>
<td>Basic Electrical Construction Drawings (Module 26110-11)</td>
<td></td>
</tr>
<tr>
<td>ELT1.11</td>
<td>Residential Electrical Services (Module 26111-11)</td>
<td></td>
</tr>
<tr>
<td>ELT2.6</td>
<td>Conductor Installations (Module 26206-11)</td>
<td></td>
</tr>
<tr>
<td>ELT2.10</td>
<td>Circuit Breakers and Fuses (Module 26210-11)</td>
<td></td>
</tr>
</tbody>
</table>
Course Name: Commercial and Industrial Wiring

Course Abbreviation: ELT 1123

Classification: Career, Technical, and Associate Degree Core

Description: Instruction and practice in the installation of commercial and industrial electrical services including the types of conduit and other raceways, NEC code requirements, and three-phase distribution networks. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3), Residential/Light Commercial Wiring (ELT 1113), or by permission of instructor

Competencies and Suggested Objectives

1. Apply general safety rules and current NEC and local codes. DOK 3, ELT1.2, ELT1.5
   a. Explain and demonstrate safety rules and regulations for working near or on load centers and safety switches.
   b. Explain and demonstrate the ability of safe lifting and work habits.
   c. Identify the code requirements for industrial and commercial locations.

2. Install and maintain raceways, conduit, and fittings. DOK2, ELT2.4, ELT1.8
   a. Identify types of raceways, conduit, and fittings.
   b. Apply usage of raceways, conduit, and fittings as required by electrical codes.
   c. Demonstrate the use of mechanical and hydraulic conduit benders to make specified bends to different sizes and types of conduit.
   d. Identify other types of raceways and their associated bodies.

3. Explain different types of three-phase service entrances, metering devices, main panels, raceways or ducts, subpanels, feeder circuits, and branch circuits according to electrical codes. DOK2, ELT3.8, ELT3.6
   a. Explain the codes NEC and local codes) for the installation of a three-phase service entrance.
   b. Explain safety precautions to be used when installing a three-phase service entrance.
   c. Construct a sketch to install a three-phase service entrance.
   d. Explain terms associated with a three-phase service entrance from codes and industry terminology.
   e. Identify components of a three-phase service entrance.

4. Prepare a job estimate including supplies and labor costs. DOK2, ELT1.10
   a. Compute the local labor cost for a given job.
   b. Determine amount of supplies for a given job.
   c. Compute the cost of supplies for a given job.
   d. Justify in writing the total cost for a given job.

STANDARDS

National Center for Construction Education and Research Standards
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELT1.2</td>
<td>Electrical Safety (Module 26102-11)</td>
</tr>
<tr>
<td>ELT1.5</td>
<td>Introduction to the National Electrical Code (Module 26105.11)</td>
</tr>
<tr>
<td>ELT1.8</td>
<td>Raceways and Fittings (Module 26108.11)</td>
</tr>
<tr>
<td>ELT1.10</td>
<td>Basic Electrical Construction Drawings (Module 26110-11)</td>
</tr>
<tr>
<td>ELT2.4</td>
<td>Conduit Bending (Module 26204-11)</td>
</tr>
<tr>
<td>ELT3.6</td>
<td>Distribution Equipment (Module 26306-11)</td>
</tr>
<tr>
<td>ELT3.8</td>
<td>Commercial Electrical Services (Module 26308-11)</td>
</tr>
</tbody>
</table>
Course Name: Introduction to the National Electric Code

Course Abbreviation: ELT 1133

Classification: Career, Technical, and Associate Degree Elective

Description: This is a course in the layout, format, rules, and regulations set forth in the National Electric Code. Emphasis is placed on developing the student’s ability to find information in the National Electric Code and applying that information in real-world applications. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: None

Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>1. Use the NEC as a reference manual to locate information and give a reference of where the information can be found. DOK3, ELT1.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Find and interpret the requirements for installing various electrical equipment and conductors in dry, damp, and wet locations.</td>
</tr>
<tr>
<td>b. Calculate the size of the current carry conductors needed to supply a circuit.</td>
</tr>
<tr>
<td>c. Calculate the current carrying capabilities of conductors with variances in the number of conductors in a raceway and changes in ambient temperature.</td>
</tr>
<tr>
<td>d. Calculate the size of service conductors for the ungrounded, grounded, and grounding conductor.</td>
</tr>
<tr>
<td>e. Calculate the number of specific current carry conductors that can be installed in a raceway.</td>
</tr>
</tbody>
</table>

STANDARDS

National Center for Construction Education and Research Standards

ELT1.5 Introduction to the National Electrical Code (Module 26105.11)
Course Name: AC and DC Circuits for Electrical Technology

Course Abbreviation: ELT 1144

Classification: Career, Technical, and Associate Degree Core

Description: Principles and theories associated with AC and DC circuits used in the electrical trades. Includes the study of electrical circuits, laws and formulas, and the use of test equipment to analyze AC and DC circuits (4 sch: 2-hr lecture, 4-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3) or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Demonstrate and practice general safety procedures in the school and work site environments. DOK2, ELT1.2</td>
</tr>
<tr>
<td>a. Apply relevant and appropriate safety techniques.</td>
</tr>
<tr>
<td>b. Demonstrate and comply with relevant OSHA safety standards.</td>
</tr>
<tr>
<td>2. Demonstrate and apply a basic electrical circuit. DOK3, ELT1.3, ELT2.1</td>
</tr>
<tr>
<td>a. Write numbers in scientific and engineering notation.</td>
</tr>
<tr>
<td>b. Perform mathematical manipulations with numbers expressed in engineering notation.</td>
</tr>
<tr>
<td>c. Explain the basic structure of matter to include the atom and element.</td>
</tr>
<tr>
<td>d. Explain the laws of electrical charge.</td>
</tr>
<tr>
<td>e. Differentiate among the characteristics of conductors, semiconductors, and insulators.</td>
</tr>
<tr>
<td>f. Demonstrate the ability to determine resistor types, value, tolerance, and power rating.</td>
</tr>
<tr>
<td>g. Demonstrate proper techniques for measuring resistance.</td>
</tr>
<tr>
<td>h. Discuss methods of generating electricity.</td>
</tr>
<tr>
<td>i. Explain theories of current flow including electron and conventional method.</td>
</tr>
<tr>
<td>j. Demonstrate principles of and operation of batteries.</td>
</tr>
<tr>
<td>k. Explain and demonstrate measurement of resistance of conductors and insulators and the computation of conductance.</td>
</tr>
<tr>
<td>3. Demonstrate the meaning of and relationships among and between voltage, current, resistance, and power in AC and DC circuits. DOK3, ELT1.4, ELT1.12, ELT2.1</td>
</tr>
<tr>
<td>a. Explain the relationship between voltage, current, and resistance in AC and DC circuits.</td>
</tr>
<tr>
<td>b. State three equations used to express Ohm’s law.</td>
</tr>
<tr>
<td>c. Analyze circuit parameters using Ohm’s law.</td>
</tr>
<tr>
<td>d. Explain how power is developed in a circuit.</td>
</tr>
<tr>
<td>e. State three forms of power equations.</td>
</tr>
<tr>
<td>f. Demonstrate techniques for determining a power.</td>
</tr>
<tr>
<td>g. Explain proper techniques for connecting a voltmeter to measure voltage.</td>
</tr>
<tr>
<td>h. Explain proper techniques for connecting current meter to measure current.</td>
</tr>
<tr>
<td>i. Measure voltage.</td>
</tr>
<tr>
<td>j. Measure resistance.</td>
</tr>
<tr>
<td>k. Measure current.</td>
</tr>
</tbody>
</table>
4. Analyze and evaluate the parameters of AC and DC series circuits. [DOK3, ELT1.4, ELT1.12, ELT2.1]
   a. Identify series circuits.
   b. Compute total resistance of a series circuit.
   c. Compute current in a series circuit using Ohm’s law.
   d. Explain why current is the same at all points in a series circuit.
   e. State and apply Kirchoff’s Voltage Law in analysis of series circuits.
   f. Explain why series circuits are known as a voltage divider.
   g. Compute voltage drops in a series circuit using Ohm’s law.
   h. Compute the power developed by each resistor and the total power of a series circuit.
   i. Explain the difference between series-aiding and series-opposing voltage sources.
   j. Construct, analyze, and troubleshoot a series circuit.

5. Analyze and evaluate the parameters of AC and DC parallel circuits. [DOK3, ELT1.4, ELT1.12, ELT2.1]
   a. Identify parallel circuits.
   b. Compute total resistance of a parallel circuit.
   c. Utilize Ohm’s law to solve circuit parameters of parallel DC circuit.
   d. Explain why voltage is the same across all branches of a parallel circuit.
   e. State and apply Kirchoff’s Current Law in the analysis of parallel circuit.
   f. Explain why a parallel circuit is a current divider.
   g. Compute branch currents in a parallel resistive circuit using the current divider equation.

6. Analyze and evaluate the parameters of AC and DC series-parallel circuit. [DOK3, ELT1.4, ELT1.12, ELT2.1]
   c. Analyze series-parallel circuits for the current through and the voltage across each component.
   d. Construct, analyze, and troubleshoot a series-parallel circuit.

7. Analyze inductive and capacitive reactance in series and parallel circuits. [DOK3, ELT1.4, ELT1.12, ELT2.1]
   a. Calculate inductive reactance (X_l) using Ohm’s law or the inductive reactance formula when signal frequency and inductance are known.
   b. Solve for signal frequency when inductance and inductive reactance are known or inductance when frequency and inductive reactance are known.
   c. Calculate capacitive reactance (X_c) using Ohm’s law or the capacitive reactance formula when signal frequency and capacitance are known.
   d. Solve for signal frequency when capacitance and capacitive reactance are known or capacitance when frequency and capacitive reactance are known.
   e. Calculate all voltages and currents in series and parallel capacitive and inductive circuits.

8. Analyze transformer voltage, current, impedance transformations, and applications. [DOK3, ELT1.4, ELT1.12, ELT2.1]
   a. Explain how mutual inductance affects transformer action.
   b. Calculate primary and secondary transformer voltage and current as related to the transformer’s turns ratio.
   c. Explain the theory of reflected impedance between the primary and secondary, or
secondary’s of transformers.

d. Calculate reflected impedance given a transformer turns ratio and secondary load impedance.
e. Explain various transformer ratings, such as voltage, current, power, impedance, frequency, and efficiency.
f. Explain various transformer losses such as winding losses and core losses.
g. Discuss a variety of transformer types and applications.
h. Construct transformer circuits, and measure voltages and currents as calculated.
i. Troubleshoot a transformer using an ohmmeter and/or voltmeter.

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<tr>
<td>ELT1.3</td>
<td>Introduction to Electrical Circuits (Module 26103.11)</td>
</tr>
<tr>
<td>ELT1.4</td>
<td>Electrical Theory (Module 26104.11)</td>
</tr>
<tr>
<td>ELT1.12</td>
<td>Electrical Test Equipment (Module 26112-11)</td>
</tr>
<tr>
<td>ELT2.1</td>
<td>Alternating Current (Module 26201-11)</td>
</tr>
</tbody>
</table>
Course Name: Computational Methods for Electrical Technology

Course Abbreviation: ELT 1153

Classification: Career, Technical, and Associate Elective

Description: Study of computational skills required for the development of accurate design and drafting methods used in the electrical technology profession. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: None

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
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</thead>
<tbody>
<tr>
<td>1. Demonstrate various measurement methods. DOK1, ELT2.1</td>
</tr>
<tr>
<td>a. Measure distances, including metric and English measurements.</td>
</tr>
<tr>
<td>b. Measure angles, including decimal degrees and degrees, minutes, and seconds.</td>
</tr>
<tr>
<td>2. Apply industry data.</td>
</tr>
<tr>
<td>a. Interpret graphs and charts.</td>
</tr>
<tr>
<td>b. Manipulate gathered information.</td>
</tr>
<tr>
<td>3. Analyze complex geometric shapes.</td>
</tr>
<tr>
<td>a. Calculate area using metric and English systems.</td>
</tr>
<tr>
<td>b. Calculate volume using metric and English systems.</td>
</tr>
<tr>
<td>c. Solve geometric construction based on area/volume solutions.</td>
</tr>
<tr>
<td>4. Calculate trigometric values. DOK2, ELT2.1</td>
</tr>
<tr>
<td>a. Calculate angle values of a triangle.</td>
</tr>
<tr>
<td>b. Solve geometric construction based on angular solutions.</td>
</tr>
<tr>
<td>5. Calculate industry expenses.</td>
</tr>
<tr>
<td>a. Prepare a cost analysis.</td>
</tr>
<tr>
<td>b. Compute overhead expenses.</td>
</tr>
<tr>
<td>a. Use a calculator.</td>
</tr>
<tr>
<td>b. Solve basic algebraic equations and conversions from fraction to decimal and metric.</td>
</tr>
</tbody>
</table>

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ELT2.1 Alternating Current (Module 26201-11)
Course Name: Drafting for Electrical Technology

Course Abbreviation: ELT 1163

Classification: Career, Technical, and Associate Elective

Description: Preparation and interpretation of schematics and electrical drawing and electrical blueprints (3 sch: 1-hr lecture, 4-hr lab)

Prerequisite: Fundamentals of Electricity ELT 1192 or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
</table>
| 1. Demonstrate an understanding of drafting fundamentals utilizing both hand- and computer-aided drafting and how it relates to the electrical industry.  
  a. Explain the need for national drafting standards.  
  b. Explain the need for drawing quality and standard drawing sizes.  
  c. Explain the requirements for lettering and different line widths.  
  d. Discuss computer aided design (CAD). |
| 2. Demonstrate an understanding of electrical symbols, components, and references used in schematic and logic diagrams.  
  a. Identify components by symbol.  
  b. Draw component and schematic symbols to drafting standards.  
  c. Correctly use component references and values.  
  d. Use symbols in schematic diagrams.  
  e. Interpret logic symbols.  
  f. Create formal drawings from an engineering sketch. |
| 3. Demonstrate the ability to compose projections and electrical drawings and diagrams.  
  a. Define and identify a perspective drawing.  
  b. Define and create orthographic, isometric, and oblique drawings.  
  c. Apply rules of good dimensioning to mechanical drawing.  
  d. Create printed circuit board assembly drawings.  
  e. Create block, flow, and single line diagrams.  
  f. Create schematic and logic diagrams.  
  g. Create point-to-point and pictorial point-to-point diagrams.  
  h. Create cable assemblies and interconnection diagrams. |
| 4. Demonstrate an understanding of electronics drafting using CAD.  
  a. Create electronic symbols to drafting standards.  
  b. Insert symbols into drawings.  
  c. Use CAD commands to create drawings and schematic diagrams. |

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ELT1.10 Basic Electrical Construction Drawings
Course Name: Fundamentals of Electricity

Course Abbreviation: ELT 1192-3

Classification: Career, Technical, and Associate Core

Description: Fundamental skills associated with all electrical courses. Safety, basic tools, special tools, equipment, and introduction to simple AC and DC circuits (2 sch: 1-hr lecture, 2-hr lab)

Prerequisite: None

Competencies and Suggested Objectives

1. Apply general safety procedures in the shop, lab, and industrial environment. DOK1, ELT1.2
   a. Apply proper safety techniques for all types of circuits and components.
   b. Demonstrate an understanding of and comply with relevant OSHA safety standards.
   c. Demonstrate the use of lockout and tagout electrical procedures.

2. Demonstrate use of electrical tools, equipment, and references. DOK2, ELT1.7, ELT1.12
   a. Identify and demonstrate proper use of basic tools. Identify and demonstrate proper use of basic equipment including meters, drills, threaders, conduit benders, and other equipment.
   b. Demonstrate the use of and reading of a rule, tape, and architectural scale.
   c. Locate and interpret information in the NEC relative to a specific job.

3. Solve problems using Ohm’s law. DOK1, ELT1.3
   a. List three formulae for Ohm’s law.
   b. Solve problems for an unknown voltage, amperage, resistance, and wattage.

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ELT1.2 Electrical Safety (Module 26102-11)
ELT1.3 Introduction to Electrical Circuits (Module 26103.11)
ELT1.7 Hand Bending (Module 26107.11)
ELT1.12 Electrical Test Equipment (Module 26112-11)
Course Name: Electric Power

Course Abbreviation: ELT 1213

Classification: Career, Technical, and Associate Core

Description: Electrical motors and their installation. Instruction and practice in using the different types of motors, transformers, and alternators (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3) or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Discuss safety and environmental protection concerns associated with electrical power equipment. DOK1, ELT3.7</td>
</tr>
<tr>
<td>a. List safety precautions associated with motors and transformers.</td>
</tr>
<tr>
<td>b. Explain the procedures for working with and disposing of hazardous materials.</td>
</tr>
<tr>
<td>2. Wire single-phase electrical components. DOK2, ELT2.2, ELT3.7</td>
</tr>
<tr>
<td>a. Sketch and connect a single-phase transformer for high- and low-voltage applications.</td>
</tr>
<tr>
<td>b. Identify, sketch, and wire different types of single-phase motors.</td>
</tr>
<tr>
<td>c. Explain and demonstrate the applications of an AC generator.</td>
</tr>
<tr>
<td>3. Wire three-phase electrical components. DOK2, ELT2.2, ELT3.7</td>
</tr>
<tr>
<td>a. Sketch and connect a three-phase AC transformer to include delta and wye and three-wire and four-wire systems.</td>
</tr>
<tr>
<td>b. Identify, draw, and wire different types of three-phase motors to include low and high voltage requirements.</td>
</tr>
</tbody>
</table>

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| ELT2.2 | Motors: Theory and Application (Module 26202-11) |
| ELT3.7 | Transformers (Module 26307-11) |
Course Name: Motor Maintenance and Troubleshooting

Course Abbreviation: ELT 1223

Classification: Career, Technical, and Associate Elective

Description: Principles and practice of electrical motor repair. Includes topics on the disassembly/assembly and preventive maintenance of common electrical motors (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3) or by permission of instructor

Competencies and Suggested Objectives

| 1. | Apply general safety and safety requirements for working with electric motors. | DOK1, ELT1.2 |
|    | a. Apply principles of safety in the use and repair of electrical motors. |          |
|    | b. Describe safety procedures to utilize during connecting, operating, and repairing of electrical motors. |          |
|    | c. Practice lockout/tagout procedure. |          |
| 2. | Use instruments and tools in maintaining, troubleshooting, and operating electrical motors. | DOK2, ELT1.12 |
|    | a. Identify, describe, and demonstrate the use of instruments and tools used to maintain, troubleshoot, and repair motors to include mega-ohm meters, volt-amp meters, and multimeters. |          |
|    | b. Describe the procedures for the maintenance, testing, and/or repair of instruments and tools. |          |
| 3. | Troubleshoot and perform basic maintenance on electrical motors. | DOK2, ELT1.2 |
|    | a. List and describe functions of the major parts and windings of single-phase motors. |          |
|    | b. List and describe the functions of split-phase, capacitor start, capacitor start-capacitor run, and permanent split capacitor electric motors. |          |
|    | c. Describe and list the functions of a shaded pole and repulsion/induction electric motors. |          |
|    | d. List and describe functions of major parts and windings of three-phase motors to include squirrel cage induction, synchronous, and wound rotor motors. |          |
|    | e. List and describe functions of the major parts and windings of DC motors to include series, shunt, and compound wound motors. |          |
|    | f. Develop a preventive maintenance program for electric motors. |          |

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ELT1.2 Electrical Safety (Module 26102-11)
ELT1.12 Electrical Test Equipment (Module 26112-11)
ELT2.2 Motors: Theory and Application (Module 26202-11)
Course Name: Branch Circuit and Service Entrance Calculations

Course Abbreviation: ELT 1253

Classification: Career, Technical, and Associate Core

Description: Calculating circuit sizes for all branch circuits and service entrances in residential installation (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Residential/Light Commercial Wiring (ELT 1113) or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
</table>
| 1. Explain size and color of equipment grounding conductors for all branch circuits.  
  a. Explain the different colors of equipment grounding conductors for all branch circuits.  
  b. Explain the equipment grounding conductor sizes in relationship to the rating or setting of the automatic overcurrent device ahead of the equipment (per NEC). |
| 2. Determine the minimum number of general-purpose branch circuits needed in a residential structure.  
  a. Calculate the usable square footage of a dwelling for general-purpose application.  
  b. Compute the minimum wattage by NEC standards for total watts for general-purpose lighting and appliance circuits.  
  c. Compute the minimum number of 15-A or 20-A general-purpose branch circuits. |
| 3. Calculate the branch circuit sizes for individual branch circuits for residential wiring.  
  a. Calculate the branch circuit conductor size for motors according to NEC.  
  b. Calculate the branch circuit conductor size for air conditioning and refrigeration equipment according to NEC.  
  c. Calculate the branch circuit size for appliances according to NEC.  
  d. Calculate the branch circuit size for heat according to NEC. |
| 4. Calculate the minimum number of branch circuits of the small appliance and laundry types.  
  a. Explain the circuit size and specified area use of the small appliance and laundry branch circuits.  
  b. Explain the exceptions permitted by the NEC as to circuit area usage of small appliance branch circuits. |
| 5. Explain and demonstrate the procedure for calculating the residential service entrance conductor size using the standard or optional method according to NEC.  
  a. Calculate the wattage of the small appliance and laundry circuits as specified in NEC.  
  b. Calculate the wattage of general-purpose branch circuits as specified in NEC.  
  c. Calculate the wattage of all appliances that may be permanently connected or on a specific circuit.  
  d. Demonstrate the procedure for calculating the heat and air-conditioning load as specified in NEC. |

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<tr>
<td>ELT3.1</td>
<td>Load Calculations – Branch and Feeder Circuits (Module 26301-11)</td>
<td></td>
</tr>
<tr>
<td>ELT3.2</td>
<td>Conductor Selection and Calculations (Module 26302-11)</td>
<td></td>
</tr>
</tbody>
</table>
Course Name: Blueprint Reading/Planning in Residential Installation

Course Abbreviation: ELT 1263

Classification: Career, Technical, and Associate Core

Description: Architectural symbols and electric symbols needed to read blueprints. All elevations and various plans associated with electrical wiring will be studied. Blank blueprints will be provided, and a list of all appliances and their amperage will be supplied. The blanks will be filled with receptacles, switches, and lighting outlets as required by NEC. Circuit layouts for all switching will be demonstrated. All branch circuits will be plotted on the blueprint. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3) or by permission of instructor

Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>Competency</th>
<th>Objective</th>
<th>DOK1, ELT1.10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Explain ANSI symbols used in blueprint reading.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. List and explain symbols used for circuits.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. List and explain symbols used for lights, switches, appliances, and special connectors.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Explain plans and elevations critical to blueprint reading.</td>
<td></td>
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<tr>
<td></td>
<td>a. List the various plans.</td>
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<tr>
<td></td>
<td>b. Name the principal elevations.</td>
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<tr>
<td></td>
<td>c. Draw a basic floor plan.</td>
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<tr>
<td></td>
<td>d. Draw the four principal elevations.</td>
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</tr>
<tr>
<td>3.</td>
<td>Determine service entrance locations and heights.</td>
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<tr>
<td></td>
<td>a. Determine proper heights to install wall bracket lights and weatherproof GFCI outlets.</td>
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<tr>
<td></td>
<td>b. Determine finished grade and exterior structure finish.</td>
<td></td>
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<tr>
<td>4.</td>
<td>Locate vertical wall receptacles, switches, and lighting outlets.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Sketch the location of all receptacles.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Sketch the location of all lights and switches.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Sketch the location of all special outlets.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Prepare blueprints to meet NEC minimum requirements.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Locate all receptacles, switches, and lighting outlets in each room.</td>
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<tr>
<td></td>
<td>b. Determine the wiring circuits for all light switching.</td>
<td></td>
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<tr>
<td></td>
<td>c. Lay out all appliances, multi-wire, individual, and general-purpose branch circuits.</td>
<td></td>
</tr>
</tbody>
</table>

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ELT1.10 Basic Electrical Construction Drawings (Module 26110-11)
Course Name: Switching Circuits for Residential, Commercial, and Industrial Applications

Course Abbreviation: ELT 1273

Classification: Career, Technical, and Associate Elective

Description: Introduction to various methods by which single-pole, 3-way, and 4-way switches are used in residential, commercial, and industrial installations. Also includes installation and operation of residential/commercial automation systems (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3) or by permission of instructor

Competencies and Suggested Objectives

1. Demonstrate various switching circuits.  
   a. Explain the mechanical and electrical operation of various switches using the different wiring arrangements.  
   b. Demonstrate the single-pole switching arrangements with two-wire when the lighting outlet and switch are fed.  
   c. Demonstrate the various three-way and four-way switching circuits using two-wire or three-wire cable.  
   d. Demonstrate objectives 1a-1c using a conduit raceway.

2. Demonstrate and explain low voltage remote control wiring in residential/commercial automation systems.  
   a. Demonstrate and explain the procedure for installing the residential/commercial automation systems.  
   b. Explain the procedure for programming the residential/commercial automation systems.

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<tr>
<td>ELT1.9</td>
<td>Conductors and Cables (Module 26109-11)</td>
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</tr>
<tr>
<td>ELT1.11</td>
<td>Residential Electrical Services (Module 26111-11)</td>
<td></td>
</tr>
<tr>
<td>ELT3.8</td>
<td>Commercial Electrical Services (Module 26308-11)</td>
<td></td>
</tr>
</tbody>
</table>
Course Name: Estimating the Cost of an Electrical Installation

Course Abbreviation: ELT 1283

Classification: Career, Technical, and Associate Elective

Description: Cost of an electrical installation. Specifications set forth for a particular structure (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3), Residential/Commercial Wiring (ELT 1113), or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Calculate the total projected cost of materials and labor by using the results of a time and motion study, actual cost of materials, and margin of profit. DOK1, ELT1.6, ELT1.9</td>
</tr>
<tr>
<td>a. Prepare a lighting fixture schedule for a structure by determining which circuits require specific lights for the individual rooms.</td>
</tr>
<tr>
<td>b. Prepare a branch circuit material schedule.</td>
</tr>
<tr>
<td>c. Prepare a labor unit schedule for an electrical installation.</td>
</tr>
<tr>
<td>d. Prepare an estimate of materials used in an installation</td>
</tr>
<tr>
<td>2. Prepare a branch circuit schedule. DOK1, ELT1.6, ELT1.9</td>
</tr>
<tr>
<td>a. Determine which rooms are on a particular branch circuit.</td>
</tr>
<tr>
<td>b. Determine the number of lighting outlets that are on the particular branch circuit.</td>
</tr>
<tr>
<td>c. Determine the number of switch outlets that are on a particular branch circuit.</td>
</tr>
<tr>
<td>d. Determine the number of receptacle outlets that are on a particular branch circuit.</td>
</tr>
</tbody>
</table>

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ELT1.6 Device Boxes (Module 26106.11)
ELT1.9 Conductors and Cables (Module 26109-11)
Course Name: Automated Manufacturing Controls for Electrical Technology

Course Abbreviation: ELT 1313

Classification: Career, Technical, and Associate Elective

Description: This course is designed to teach the students the integrated control systems found in automated systems. Emphasis will be placed on encoders, optical devices, servo motors, stepper motors, computerized numerical control (CNC), vision and sensing systems, lasers, programmatic controllers, solid state motor controls, and other similar devices. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Motor Controls ELT1413, PLC’s ELT 2613, Solid State Motor Controls ELT 2424, or by permission of instructor

Competencies and Suggested Objectives

1. Demonstrate the ability to develop a robotics process utilized in the electrical industry.
   DOK2, ELT3.11, ELT4.7, ELT4.10
   a. Plan a process.
   b. Design and lay out a process using a programmable logic control.

2. Demonstrate the ability to interface components of a robotics process and how they relate to the electrical industry.
   DOK2, ELT3.11, ELT4.7, ELT4.10
   a. Integrate communication links between PLC, computer, and robot.
   b. Integrate and maintain interlock of sequential operations using PLC and control wiring.
   c. Utilize contact and noncontact sensors.
   d. Integrate peripheral equipment into the process.

3. Demonstrate the ability to evaluate and troubleshoot a robotics process.
   DOK2, ELT3.11, ELT4.7, ELT4.10
   a. Evaluate system performance.
   b. Apply problem-solving logic.
   c. Read and interpret schematics.
   d. Explain and operate basic test equipment.

STANDARDS

National Center for Construction Education and Research Standards

ELT3.11 Motor Controls (Module 26311-11)
ELT4.7 Advanced Controls (Module 26407-11)
ELT4.10 Motor Operation and Maintenance (Module 26410-11)
Course Name: Calibration and Measurement Principles Used in the Electrical Industry

Course Abbreviation: ELT 1324

Classification: Career, Technical, and Associate Elective

Description: This course introduces the students to various terms related to measurement principles and calibration techniques used in the electrical industry. With PLCs, the topic also includes the procedures and calibration of various instruments and PLCs used in industry. (4 sch: 3-hr lecture, 2-hr lab)

Prerequisite: Programmable Logic Controls ELT 2613 and Advanced Programmable Controls ELT 2623

Competencies and Suggested Objectives

| 1. | Define terms associated with measurement and calibration procedures used in the electrical industry. | DOK1, INS2.4, INS2.5, INS 2.6, INS2.7, INS2.12, INS2.13, INS2.14 |
|    | a. Describe traceability of a standard. | |
|    | b. Describe and explain static and dynamic characteristics of an instrument. | |
|    | c. Explain elevated and suppressed zero. | |
|    | d. Discuss instrument drift. | |
|    | e. Discuss units of measurement pertaining to instrumentation. | |
| 2. | Describe a standard calibration procedure used in the electrical industry. | DOK2, INS2.4, INS2.5, INS 2.6, INS2.7, INS2.12, INS2.13, INS2.14 |
|    | a. Develop a generic calibration procedure. | |
|    | b. Perform a calibration procedure on different instrumentation apparatus. | |
|    | c. Calibrate a PLC for installation. | |
| 3. | Describe and demonstrate Statistical Process Control (SPC). | DOK2, INS2.4, INS2.5, INS 2.6, INS2.7, INS2.12, INS2.13, INS2.14 |
|    | a. Perform basic operations of statistics. | |
|    | b. Explain statistics and the relationship to process control instrumentation. | |

STANDARDS

National Center for Construction Education and Research Standards

INS2.4 Process Control Theory (Module 12204-03)
INS2.5 Detectors, Secondary Elements, Transducers, and Transmitters (Module 12205-03)
INS2.6 Controllers, Recorders, and Indicators (Module 12206-03)
INS2.7 Control Valves, Actuators, and Positioners (Module 12207-03)
INS2.12 Panel-Mounted Instruments (Module 12212-03)
INS2.13 Installing Field-Mounted Instruments (Module 12213-03)
INS2.14 Raceways for Instrumentation (Module 12214-03)
Course Name: Flexible Manufacturing Systems for Electrical Technology

Course Abbreviation: ELT 1334

Classification: Career, Technical, and Associate Elective

Description: This course is a production project that requires the student to apply technical skills acquired in previous courses. Project management is provided by the instructor with the students working as teams in each particular area of the manufacturing system. The students are required to plan the project and prepare the integrated system to manufacture a product. This includes all software, hardware, fixtures, clamping mechanisms, material handling requirements, sensors and interfacing, and external control devices. (4 sch: 2-hr lecture, 4-hr lab)

Prerequisite: Motor Controller (ELT 1413), Advanced PLCs (ELT 2623), Solid State Motor Controls (ELT 2424), or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
</table>
| 1. Plan a project that will utilize the automated system used in the electrical industry.  
  a. Develop documentation that outlines major steps in the program.  
  b. Develop a process flowchart that identifies and sequences primary production steps.  
   DOK3, ELT3.11, ELT4.7 |
| 2. Plan and specify the automation equipment required for the electrical project.  
  a. Identify the automation equipment required to support the project.  
  b. Identify and list the individual process steps with supporting addresses and control data.  
  c. Identify the material requirements.  
   DOK2, ELT3.11, ELT4.7 |
| 3. Develop and program the project.  
  a. Develop the initialization programming logic.  
  b. Develop the input/output logic.  
  c. Develop the process control logic.  
   DOK3, ELT3.11, ELT4.7 |
| 4. Test and debug the project.  
  a. Configure the automation system for the project.  
  b. Troubleshoot and correct the program syntax and logic problems.  
   DOK2, ELT3.11, ELT4.7 |

STANDARDS

National Center for Construction Education and Research Standards

ELT3.11 Motor Controls (Module 26311-11)  
ELT4.7 Advanced Controls (Module 26407-11)
Course Name: Fundamentals of Instrumentation

Course Abbreviation: ELT 1343

Classification: Career, Technical, and Associate Elective

Description: This course provides students with a general knowledge of instrumentation principles as they relate to the electrical industry. This course includes instruction in the basis of hydraulics and pneumatics and the use of electrical circuits in the instrumentation process. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3), AC and DC Circuits (ELT 1144), or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Demonstrate a working knowledge of instrumentation as it pertains to the electrical industry. DOK2, INS1.1, INS1.3, INS1.4, INS1.7, INS1.10</td>
</tr>
<tr>
<td>a. Define terms associated with instrumentation.</td>
</tr>
<tr>
<td>b. Discuss basic theory of hydraulics, pneumatics, and electromagnetic controls.</td>
</tr>
<tr>
<td>c. Identify basic symbols used with hydraulics, pneumatics, and electromagnetic systems.</td>
</tr>
<tr>
<td>2. Identify the type of instrumentation input and output devices, and describe their applications. DOK2, INS1.1, INS1.3, INS1.4, INS1.7, INS1.10</td>
</tr>
<tr>
<td>a. Describe control elements for pressure, flow, temperature, and level.</td>
</tr>
<tr>
<td>b. Identify the types of input and output devices.</td>
</tr>
<tr>
<td>c. Describe the input and output devices.</td>
</tr>
<tr>
<td>3. Identify the types of electrical signals used in instrumentation. INS1.10</td>
</tr>
<tr>
<td>a. Describe the transmission of information to include current, pressure, and frequency.</td>
</tr>
<tr>
<td>b. Explain the principles of the transmission information input and output.</td>
</tr>
<tr>
<td>4. Describe fundamentals of electrical and electronic process controls. DOK1, INS1.1, INS1.3, INS1.4, INS1.7, INS1.10</td>
</tr>
<tr>
<td>a. Label a block diagram of an open loop system and a closed loop system.</td>
</tr>
<tr>
<td>b. Describe characteristics of an open loop and a closed loop system.</td>
</tr>
<tr>
<td>5. Design a preventive maintenance program for instrumentation systems. DOK2, INS1.1, INS1.3, INS1.4, INS1.7, INS1.10</td>
</tr>
<tr>
<td>a. Describe the techniques and procedures for troubleshooting, calibrating, and repairing an instrumentation system.</td>
</tr>
<tr>
<td>b. Demonstrate the ability to sketch a piping and instrument drawing.</td>
</tr>
</tbody>
</table>
### National Center for Construction Education and Research Standards

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>INS1.1</td>
<td>Hand Tools for Instrumentation (Module 12101-01)</td>
</tr>
<tr>
<td>INS1.3</td>
<td>Power Tools for Instrumentation (Module 12103-01)</td>
</tr>
<tr>
<td>INS1.4</td>
<td>Electrical Systems for Instrumentation (Module 12104-01)</td>
</tr>
<tr>
<td>INS1.7</td>
<td>Instrumentation Drawings and Documents, Part One (Module 12107-01)</td>
</tr>
<tr>
<td>INS1.10</td>
<td>Flow, Pressure, Level, and Temperature (Module 12110-01)</td>
</tr>
</tbody>
</table>
Course Name: Fundamentals of Robotics for Electrical Technology

Course Abbreviation: ELT 1353

Classification: Career, Technical, and Associate Elective

Description: This course is designed to introduce the student to industrial robots. Topics to be covered include robotics history, industrial robot configurations, operation, and basic programming and how they relate to the electrical industry. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3), Motor Controls (ELT 1413), PLCs (ELT 2613), Solid State Motor Control (ELT 2424), and Automated Manufacturing Controls for Electrical Technology (ELT 1313).

Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>1.</th>
<th>Describe the various major components of all robots. DOK1, EST3.7, INS1.1, INS1.2, INS1.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Explain the axes of movement.</td>
</tr>
<tr>
<td>b.</td>
<td>Label each major component.</td>
</tr>
<tr>
<td>c.</td>
<td>Identify four general types of work envelopes.</td>
</tr>
<tr>
<td>d.</td>
<td>Discuss three general forms of robot actuation.</td>
</tr>
<tr>
<td>e.</td>
<td>Identify different types of input devices used with robot controllers.</td>
</tr>
<tr>
<td>f.</td>
<td>Describe the characteristics of a robot that distinguish it from other types of automated machinery.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2.</th>
<th>Demonstrate safety procedures used in the automated environment. DOK1, EST3.7, INS1.1, INS1.2, INS1.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Apply safety rules for personal and general shop safety including eye, ear, and body protection; general rules of shop conduct; and the use of safety color coding.</td>
</tr>
<tr>
<td>b.</td>
<td>Apply general safety rules for tool and equipment use including hand tools, air and electric power tools, and other shop equipment.</td>
</tr>
<tr>
<td>c.</td>
<td>Apply general safety rules associated with working on various robotics systems.</td>
</tr>
<tr>
<td>d.</td>
<td>Apply rules and procedures associated with fire safety including procedures for handling and storing flammable liquids and proper use of firefighting devices.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3.</th>
<th>Demonstrate the ability to operate robots. DOK1, EST3.7, INS1.1, INS1.2, INS1.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Evaluate robot performance.</td>
</tr>
<tr>
<td>b.</td>
<td>Apply basic programming skills.</td>
</tr>
<tr>
<td>c.</td>
<td>Identify and discuss end effectors.</td>
</tr>
<tr>
<td>d.</td>
<td>Identify and discuss visual and tactile sensors.</td>
</tr>
<tr>
<td>e.</td>
<td>Demonstrate basic troubleshooting techniques.</td>
</tr>
</tbody>
</table>

STANDARDS

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EST3.7 Maintenance and Repair (Module 33307-11)
INS1.1 Hand Tools for Instrumentation (Module 12101-01)
INS1.2 Electrical Safety (Module 12102-01)
INS1.3  Power Tools for Instrumentation (Module 12103-01)
Course Name: Industrial Hydraulics for Electrical Technology

Course Abbreviation: ELT 1363

Classification: Career, Technical, and Associate Elective

Description: This course introduces the students to basic hydraulics, hydraulic actuators, accumulators, valves, pumps, motors, fluids, coolers, and filters. Emphasis is placed on development of hydraulic control circuits, electrical interfacing techniques, and troubleshooting. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3), Motor Controls (ELT 1413), PLCs (ELT 2613), or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Define and describe basic laws governing liquids.</td>
</tr>
<tr>
<td>a. Describe the concept of force, flow, and pressure.</td>
</tr>
<tr>
<td>b. Analyze the relationship of force and pressure of a circuit.</td>
</tr>
<tr>
<td>c. Explain what causes flow in a circuit.</td>
</tr>
<tr>
<td>d. Calculate area, pressure, velocity, and rate of flow.</td>
</tr>
<tr>
<td>e. Explain and apply Pascal’s law in hydraulics.</td>
</tr>
<tr>
<td>2. Identify and draw symbols for hydraulics used in the electrical industry.</td>
</tr>
<tr>
<td>a. Explain the logic for drawing symbols for hydraulic components.</td>
</tr>
<tr>
<td>b. Draw individual hydraulic components.</td>
</tr>
<tr>
<td>3. Describe operation and nomenclature of various pumps.</td>
</tr>
<tr>
<td>a. Analyze the operation of vane, gear, and piston pumps.</td>
</tr>
<tr>
<td>b. Describe the operation of centrifugal pumps.</td>
</tr>
<tr>
<td>4. Explain liquids as pertaining to the transmission of energy.</td>
</tr>
<tr>
<td>a. Describe various types of hydraulic fluid.</td>
</tr>
<tr>
<td>b. Explain the purpose of the fluid reservoir, filtration system, and the heat exchange in hydraulics.</td>
</tr>
<tr>
<td>c. Illustrate the relationship of viscosity, temperature, and resistance.</td>
</tr>
<tr>
<td>5. Describe the operation of flow, pressure, and directional control valves.</td>
</tr>
<tr>
<td>a. Explain basic design features used in each type of control valve.</td>
</tr>
<tr>
<td>b. Demonstrate how flow, pressure, and directional valves are used.</td>
</tr>
<tr>
<td>6. Explain the types of actuators used in hydraulics.</td>
</tr>
<tr>
<td>a. List important cylinder design features.</td>
</tr>
<tr>
<td>b. Explain basic design features of hydraulic motors and other rotary actuators.</td>
</tr>
<tr>
<td>7. Explain, construct, and troubleshoot various hydraulic applications in the electrical industry.</td>
</tr>
<tr>
<td>a. Explain the purpose of a sequence circuit.</td>
</tr>
<tr>
<td>b. Construct and troubleshoot a sequence circuit.</td>
</tr>
<tr>
<td>c. Explain the purpose of a counterbalance circuit.</td>
</tr>
<tr>
<td>d. Construct and troubleshoot a counterbalance circuit.</td>
</tr>
</tbody>
</table>
8. Interface electrical and hydraulic circuits. DOK2, IMM3.11
   a. Wire an electrical control circuit.
   b. Interface a hydraulic circuit with ladder logic.
   c. Interface a hydraulic circuit with PLCs.

STANDARDS

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IMM3.11 Hydraulic Controls (Module 40311-09)
Course Name: Industrial Pneumatics for Electrical Technology

Course Abbreviation: ELT 1373

Classification: Career, Technical, and Associate Elective

Description: This course introduces the students to basic pneumatic principles, compression of air, work devices, control devices, and circuit diagrams. Emphasis is placed on development of pneumatic control circuits, electromechanical control of fluid power, and troubleshooting techniques. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3), Motor Controls (ELT 1413), PLCs (ELT 2613), or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Define and describe basic laws governing gases. DOK2, IMM3.12</td>
</tr>
<tr>
<td>a. Describe the concept of force, flow, and pressure.</td>
</tr>
<tr>
<td>b. Analyze the relationship of force and pressure on a circuit.</td>
</tr>
<tr>
<td>c. Explain what causes flow in a circuit.</td>
</tr>
<tr>
<td>d. Calculate area, pressure, velocity, and rate of flow.</td>
</tr>
<tr>
<td>e. Explain and apply Charles’ law in pneumatics.</td>
</tr>
<tr>
<td>f. Explain and verify Boyle’s law in a circuit.</td>
</tr>
<tr>
<td>2. Identify and draw symbols for pneumatics used in the electrical industry. DOK1, IMM3.12</td>
</tr>
<tr>
<td>a. Explain the logic for drawing symbols for pneumatic components.</td>
</tr>
<tr>
<td>b. Draw individual pneumatic components.</td>
</tr>
<tr>
<td>3. Describe the operation and nomenclature of various compressors. DOK2, IMM3.12</td>
</tr>
<tr>
<td>a. Analyze the operation of vane and piston pumps in pneumatics.</td>
</tr>
<tr>
<td>b. Analyze the operation of air compressors.</td>
</tr>
<tr>
<td>4. Explain fluids as pertaining to the transmission of energy. DOK2, IMM3.12</td>
</tr>
<tr>
<td>a. Explain the purpose of the receiver tanks, filtration system, and heat exchanger.</td>
</tr>
<tr>
<td>b. Describe the purpose of pressure drops in pneumatic systems.</td>
</tr>
<tr>
<td>5. Describe the operation of flow, pressure, and directional control valves. DOK2, IMM3.12</td>
</tr>
<tr>
<td>a. Explain basic design features used in each type of control valve.</td>
</tr>
<tr>
<td>b. Demonstrate how flow, pressure, and directional valves are used in pneumatics.</td>
</tr>
<tr>
<td>6. Explain the types of actuators used in pneumatic applications in the electrical technology. DOK1, IMM3.12</td>
</tr>
<tr>
<td>a. List important cylinder design features.</td>
</tr>
<tr>
<td>b. Explain basic design features of rotary actuators.</td>
</tr>
<tr>
<td>c. Identify common types of air motors.</td>
</tr>
<tr>
<td>7. Explain, construct, and troubleshoot various pneumatic circuits utilizing pneumatic, electrical, and electronic controls. DOK2, IMM3.12</td>
</tr>
<tr>
<td>a. Explain the purpose of a sequence circuit.</td>
</tr>
<tr>
<td>b. Construct and troubleshoot a sequence circuit.</td>
</tr>
<tr>
<td>8. Demonstrate the use of electromechanical controls in hydraulic and pneumatic circuits. DOK2, IMM3.12</td>
</tr>
<tr>
<td>a. Explain the construction and use of solenoids in directional controls.</td>
</tr>
</tbody>
</table>
b. Construct a pneumatic circuit that is controlled electrically.

STANDARDS

*National Center for Construction Education and Research Standards*

IMM3.12 Pneumatic Controls (Module 40312-09)
Course Name: Industrial Robotics for Electrical Technology

Course Abbreviation: ELT 1383

Classification: Career, Technical, and Associate Elective

Description: This course teaches the operating systems and advanced programming methods of industrial robots. Actual industrial-grade robots are used to train the student in the areas of operation, maintenance, troubleshooting, service procedures, and robotics applications. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Robotics (ELT 1353).

Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>1. Demonstrate the ability to integrate a robot into a process affiliated with the electrical industry. (DOK^2, EST^3.7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Write programs on industrial robots to perform simulated industrial processes to operate within the confines of each robot’s work envelope.</td>
</tr>
<tr>
<td>b. Demonstrate the improvement of the efficiency of an automated robotics process by reducing cycle time, decreasing memory usage, using advanced programming techniques, and so forth.</td>
</tr>
<tr>
<td>2. Demonstrate the ability to integrate peripheral equipment. (DOK^2, EST^3.7)</td>
</tr>
<tr>
<td>a. Program and interface peripheral devices such as a programmable logic controller into robotics work cells.</td>
</tr>
<tr>
<td>b. Interface contact and noncontact sensors into robotics work cell.</td>
</tr>
<tr>
<td>3. Demonstrate the ability to troubleshoot and maintain a robotics work cell. (DOK^2, EST^3.7)</td>
</tr>
<tr>
<td>a. Locate and isolate faults in robotics applications.</td>
</tr>
<tr>
<td>b. Demonstrate the use of test equipment and troubleshooting logic to repair faults.</td>
</tr>
<tr>
<td>c. Perform routine maintenance procedures on robots with the use of checklists and service equipment (null servo valves, zero encoders, calibrate potentiometers, etc.).</td>
</tr>
</tbody>
</table>

STANDARDS

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EST3.7 Maintenance and Repair (Module 33307-11)
Course Name: Servo Control Systems for Electrical Technology

Course Abbreviation: ELT 1393

Classification: Career, Technical, and Associate Elective

Description: This course is designed to teach servo components; servo valves; velocity servos; positional servos; force, pressure, and torque servos; servo amplifiers; programmers; and servo analysis. Emphasis is placed on servo trim and maintenance and the applications of servo systems. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: None

Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>Competency</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Identify and discuss the components and characteristics of a servo system used in the electrical industry. a. Identify the components of a basic electrohydraulic servo system. b. Identify servo valves as to control type and construction. c. Demonstrate operating characteristics of a servo valve by conducting performance tests. d. Explain servo valve construction, operation, and function. e. Identify the types of pilot stages for servo valves. f. Mechanically and/or electrically null a servo valve. g. Test a servo valve for flow gain, saturation, and linearity. h. Test a servo valve for pressure gain.</td>
</tr>
<tr>
<td>2.</td>
<td>Demonstrate the ability to construct and analyze open loop and closed loop systems. a. Draw a block diagram of a closed loop servo system. b. Identify and explain five control modes of a closed loop servo system. c. List and describe transducers commonly used with angular, linear, and velocity control systems. d. Construct and analyze open loop and closed loop velocity control systems. e. Construct and analyze open loop and closed loop angular position control systems. f. Construct and analyze open loop and closed loop linear position control systems. g. Demonstrate the concepts of accuracy, error, gain, response, and stability of closed loop servo systems.</td>
</tr>
<tr>
<td>3.</td>
<td>Demonstrate the ability to troubleshoot and repair a servo control system used in the electrical industry. a. Apply troubleshooting logic to solve electrical problems with a servo control system. b. Apply troubleshooting logic to locate and repair a fault in the hydraulic section of an electrohydraulic servo control system. c. Construct and demonstrate an angular position control system as it relates to a simulated machine function. d. Construct and demonstrate velocity control as it relates to a simulated machine function. e. Construct and demonstrate linear position control as it relates to a simulated machine function.</td>
</tr>
</tbody>
</table>
function.

STANDARDS

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ELT4.7 Advanced Controls (Module 26407-11)
Course Name: Motor Control Systems

Course Abbreviation: ELT 1413

Classification: Career, Technical, and Associate Core

Description: Installation of different motor control circuits and devices. Emphasis is placed on developing the student’s ability to diagram, wire, and troubleshoot the different circuits and mechanical control devices. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3) or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Install different control circuits and devices.</td>
</tr>
<tr>
<td>a. Diagram and wire a two-wire and three-wire motor control circuit with indicating pilot lights.</td>
</tr>
<tr>
<td>b. Diagram, wire, and troubleshoot an on-delay and off-delay timer circuit.</td>
</tr>
<tr>
<td>c. Diagram and wire multi-control manual station.</td>
</tr>
<tr>
<td>d. Diagram and wire a “hands-off-automatic” control station.</td>
</tr>
<tr>
<td>e. Diagram and wire a jog-forward/jog-reverse control.</td>
</tr>
<tr>
<td>2. Troubleshoot different control circuits and devices.</td>
</tr>
<tr>
<td>a. Troubleshoot a two-wire and three-wire motor control circuit with indicating pilot lights.</td>
</tr>
<tr>
<td>b. Troubleshoot an on-delay and off-delay timer circuit.</td>
</tr>
<tr>
<td>c. Troubleshoot a multi-control manual station.</td>
</tr>
<tr>
<td>d. Troubleshoot a “hands-off-automatic” control station.</td>
</tr>
<tr>
<td>e. Troubleshoot a jog-forward/jog-reverse control.</td>
</tr>
</tbody>
</table>

STANDARDS

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ELT3.9 Motor Calculations (Module 26309-11)
ELT3.11 Motor Controls (Module 26311-11)
Course Name: Solid State Devices and Circuits for Electrical Technology

Course Abbreviation: ELT 1434

Classification: Career, Technical, and Associate Elective

Description: Active devices that include PN junction diodes, bipolar transistors, bipolar transistor circuits, and unipolar devices with emphasis on low-frequency application and troubleshooting. (4 sch: 2-hr lecture, 4-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3) and AC/DC Circuits (ELT 1144) or by permission of instructor

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>1. Explain the characteristics of semiconductor materials and theory of operation of PN junctions. <strong>DOK1, ELT4.7</strong></td>
</tr>
<tr>
<td>a. Explain basic atomic structure.</td>
</tr>
<tr>
<td>b. Define intrinsic, P-type, and N-type.</td>
</tr>
<tr>
<td>c. Analyze an unbiased PN junction.</td>
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<tr>
<td>d. Analyze a forward biased PN junction.</td>
</tr>
<tr>
<td>e. Analyze a reverse biased PN junction.</td>
</tr>
<tr>
<td>2. Explain semiconductor diode theory, and apply to diode circuits. <strong>DOK2, ELT4.7</strong></td>
</tr>
<tr>
<td>a. Describe the characteristics of a diode.</td>
</tr>
<tr>
<td>b. Analyze and demonstrate half wave rectifier circuit.</td>
</tr>
<tr>
<td>c. Analyze and demonstrate full wave rectifier circuit.</td>
</tr>
<tr>
<td>d. Analyze and demonstrate bridge rectifier circuit.</td>
</tr>
<tr>
<td>3. Analyze the operation of semiconductor special purpose diodes. <strong>DOK2, ELT4.7</strong></td>
</tr>
<tr>
<td>a. Analyze and demonstrate the operation of zener diode circuit.</td>
</tr>
<tr>
<td>b. Analyze and demonstrate the operation of light emitting diode circuit.</td>
</tr>
<tr>
<td>c. Explain the characteristics of Schottkey diodes.</td>
</tr>
<tr>
<td>d. Explain the characteristics of varactor diodes.</td>
</tr>
<tr>
<td>4. Analyze the operation of bipolar junction transistors. <strong>DOK1, ELT4.7</strong></td>
</tr>
<tr>
<td>a. Define and identify transistor voltages and currents.</td>
</tr>
<tr>
<td>b. Analyze and demonstrate the operation of a DC common emitter circuit.</td>
</tr>
<tr>
<td>c. Demonstrate the use of collector curves.</td>
</tr>
<tr>
<td>d. Demonstrate the use of load lines.</td>
</tr>
<tr>
<td>e. Explain and demonstrate base, emitter, and voltage divider biasing.</td>
</tr>
<tr>
<td>5. Explain and analyze the construction of BJT amplifiers. <strong>DOK2, ELT4.7</strong></td>
</tr>
<tr>
<td>a. Analyze and discuss the basic operation of a common emitter voltage amplifier.</td>
</tr>
<tr>
<td>b. Given a common emitter amplifier circuit, draw the AC equivalent circuit, and solve for V-in, V-out, and A.</td>
</tr>
<tr>
<td>c. Explain how the swamped common emitter amplifier works, and discuss its advantages.</td>
</tr>
<tr>
<td>d. Given a swamped common emitter amplifier circuit, draw the AC equivalent circuit, and solve for Z-in, V-in, V-out, A.</td>
</tr>
</tbody>
</table>
|   e. Construct common emitter amplifier, and compare measured parameters to calculated
values.

f. Given a cascaded common emitter amplifier, calculate gain of stage one, gain of stage two, and output voltage.

g. Given a power amplifier circuit, solve for the maximum generator voltage that will produce an unclipped output signal, and solve the maximum efficiency of the amplifier.

h. Given an emitter-follower circuit, solve for Z-in, V-in, A, and V-out.

i. Describe the characteristics of a class A power amplifier to include the factors that limit the power rating of a transistor.

j. Construct class A and class B amplifiers and troubleshoot the circuits.

6. Analyze the operation of field effect transistors, and demonstrate their applications. a. Describe the basic construction of a JFET.

b. Calculate the proportional pinch off voltage, and determine the operating area of a JFET.

c. Given a JFET circuit, and determine ID and Vds.

d. Given a JFET amplifier circuit, draw the AC equivalent circuit and solve for gmo, gm, Z-in, V-in, A, and V-out.

e. Given a JFET source follower circuit with a given gm, solve for V-in, A, and V-out.

f. Illustrate the construction of and describe the operation of the depletion-mode and the enhancement-mode MOSFET.

g. Analyze other FET applications such as multiplying, switching, chopper, AGC, and sample and hold amplifier.

7. Analyze the operation of thyristors, and demonstrate their applications. a. Describe the four-layer diode, and discuss how it is turned on and off.

b. Describe how the SCR operates in different applications.

c. Construct a latching SCR with a varying input voltage, and determine when the output voltage is latched.

d. Describe the main characteristics of the variations of the SCR, and discuss the difference in device symbols.

e. Describe the characteristics of the diac and triac.

f. Calculate the intrinsic standoff voltage for a unijunction transistor (UJT), and state how it works.

g. Analyze thyristor applications such as over voltage detector, sawtooth generator, SCR crowbar, and controlled SCR circuits phase angle controlled circuits.

h. Construct thyristor circuits, and vary the latching parameters; measure the output to view switching and control of the device.

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ELT4.7 Advanced Controls (Module 26407-11)
Course Name: Data Acquisition and Communications

Course Abbreviation: ELT 1513

Classification: Career, Technical, and Associate Elective

Description: This is a course in acquisition and communication of systems data in industrial automated applications. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: By permission of instructor

Competencies and Suggested Objectives

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Explain data communication components used in automatic systems. &lt;br&gt; a. Identify characteristics and uses of various EIA standard data communication interfaces. &lt;br&gt; b. Describe standard serial communications used in computers. &lt;br&gt; c. Describe parallel communication interfaces. &lt;br&gt; d. Explain Ethernet. &lt;br&gt; e. Explain Controlnet. &lt;br&gt; f. CAN based networks.</td>
</tr>
<tr>
<td>2.</td>
<td>Use data communication software PLC and a computer to connect a network. &lt;br&gt; a. Configure a computer for serial or parallel communications. &lt;br&gt; b. Perform data transfers between computers. &lt;br&gt; c. Use communication test equipment to troubleshoot communications links.</td>
</tr>
<tr>
<td>3.</td>
<td>Use computers and/or controllers for data acquisition. &lt;br&gt; a. Interface sensors with computer or controller for data acquisition using Ethernet. &lt;br&gt; b. Configure software and computer for data acquisition from a PLC.</td>
</tr>
</tbody>
</table>

STANDARDS

National Center for Construction Education and Research Standards

ELT3.10 Voice, Data, and Video (Module 26310-11)  <br> ELT3.11 Motor Controls (Module 26311-11)  <br> ELT4.7 Advanced Controls (Module 26407-11)
Course Name: Fundamentals of Fiber Optics for Electrical Technology

Course Abbreviation: ELT 1523

Classification: Career, Technical, and Associate Elective

Description: Fiber-optic cable in modern industry applications (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3) and AC/DC Circuits (ELT 1144) or by permission of instructor

### Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>Competency</th>
<th>Description</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Demonstrate and practice general safety procedures in the school and work site environments.</td>
<td>DOK2, ELT3.10, EST1.8, EST2.7, EST2.8, EST2.9, EST3.2</td>
</tr>
<tr>
<td></td>
<td>a. Apply relevant and appropriate safety techniques.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Demonstrate an understanding of and comply with relevant OSHA safety standards.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Describe the history and advantages of fiber-optic systems and how they relate to the electrical industry.</td>
<td>DOK1, ELT3.10, EST1.8, EST2.7, EST2.8, EST2.9, EST3.2</td>
</tr>
<tr>
<td></td>
<td>a. Describe the limitations of wire communications systems.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. List the advantages of optical fiber communications over electrical wire communications.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Explain the operation and application of optical signal sources.</td>
<td>DOK1, ELT3.10, EST1.8, EST2.7, EST2.9, EST3.2</td>
</tr>
<tr>
<td></td>
<td>a. Apply appropriate safety practices to optical signal sources.</td>
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<tr>
<td></td>
<td>b. Explain the advantages and disadvantages of LEDs as optical signal sources.</td>
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<td></td>
<td>c. Explain the operation of modulator circuits for optical signal sources.</td>
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<tr>
<td>4.</td>
<td>Explain the operation and application of fiber-optic system components.</td>
<td>DOK1, ELT3.10, EST1.8, EST2.7, EST2.9, EST3.2</td>
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<tr>
<td></td>
<td>a. Describe the construction of optical fibers.</td>
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<td></td>
<td>b. Explain optical fiber cable specifications.</td>
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<td>5.</td>
<td>Describe properties of different types of optical fibers.</td>
<td>DOK2, ELT3.10, EST1.8, EST2.7, EST2.9, EST3.2</td>
</tr>
<tr>
<td></td>
<td>a. Differentiate between the properties and characteristics of plastic and glass optical fibers.</td>
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<td></td>
<td>b. Describe the effect of core size on efficiency and bandwidth.</td>
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<td></td>
<td>c. Describe fiber-optic cables available for indoor and outdoor installation.</td>
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<td></td>
<td>d. Prepare and complete a splice of fiber-optic cable following industry standards and safety procedures.</td>
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<td></td>
<td>e. Describe requirements for certification as a fiber-optic technician.</td>
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<tr>
<td>6.</td>
<td>Explain the installation, connection, terminations, and maintenance of a fiber-optic system in residential and commercial applications.</td>
<td>DOK2, ELT3.10, EST1.8, EST2.7, EST2.8, EST2.9, EST3.2</td>
</tr>
<tr>
<td></td>
<td>a. Show the proper installation of fiber-optic systems.</td>
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</tr>
<tr>
<td></td>
<td>b. Demonstrate the proper connections of fiber-optic systems.</td>
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<tr>
<td></td>
<td>c. Demonstrate the proper terminations of fiber-optic systems.</td>
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<tr>
<td></td>
<td>d. Show the proper maintenance of fiber-optic systems.</td>
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<tr>
<td>7.</td>
<td>Demonstrate an understanding of how fiber optics are covered by the NEC.</td>
<td>DOK2, ELT3.10, EST1.8, EST2.7, EST2.8, EST2.9, EST3.2</td>
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</tbody>
</table>
a. Explain protection of fiber-optic installation and terminations.
b. Demonstrate proper installations of raceways and wiring methods for fiber-optic applications.

8. Demonstrate the proper methods for termination of fiber optics.

a. List NEC references to fiber-optic installations.
b. Demonstrate proper termination methods on various fiber-optic cables.

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<tr>
<th>Code</th>
<th>Course Title</th>
<th>Module</th>
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<tbody>
<tr>
<td>ELT3.10</td>
<td>Voice, Data, and Video</td>
<td>26310-11</td>
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<tr>
<td>EST1.8</td>
<td>Low-Voltage Cabling</td>
<td>33108-10</td>
</tr>
<tr>
<td>EST2.7</td>
<td>Introduction to Codes and Standards</td>
<td>33207-10</td>
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<tr>
<td>EST2.8</td>
<td>Cable Selection</td>
<td>33208-10</td>
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<tr>
<td>EST2.9</td>
<td>Wire and Cable Terminations</td>
<td>33209-10</td>
</tr>
<tr>
<td>EST3.2</td>
<td>Fiber Optics</td>
<td>33302-11</td>
</tr>
</tbody>
</table>
Course Name: Fundamentals of Data Communications for Electrical Technology

Course Abbreviation: ELT 1533

Classification: Career, Technical, and Associate Elective

Description: Concepts of telephony, local area networks, wide area networks, data transmission, and topology methods. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: none

Competencies and Suggested Objectives

1. Discuss basic communications and how they relate to the electrical industry in modern manufacturing plants. **DOK2, ELT3.10, ELT4.5, EST2.8, EST2.9**
   - a. Analyze various communication procedures between a computer and PLC.
   - b. Explain the differences between analog and digital communication using a PLC.

2. Analyze hardware, media, and software for use in data communication used between PLCs and computers in manufacturing plants. **DOK1, ELT3.10, ELT4.5, EST2.8, EST2.9**
   - a. Discuss uses of modems.
   - b. Describe various communications media.
   - c. Describe data transmission codes and protocols.

3. Discuss communication networks and the installation of each. **DOK2, ELT3.10, ELT4.5, EST2.8, EST2.9**
   - a. Discuss industrial network basics (Ethernet, Controlnet, CAN, and Devicenet).
   - b. Analyze local area networks.
   - d. Discuss planning, design, and implementation of networks.

4. Discuss the future of communication and the electrical industry within manufacturing plants. **DOK2, ELT3.10, ELT4.5, EST2.8, EST2.9**
   - a. Analyze current trends and issues.
   - b. Utilize teleconferencing/video conferencing techniques.

5. Demonstrate the use of the Internet. **DOK1, ELT3.10, ELT4.5, EST2.8, EST2.9**
   - a. Explain what the Internet is.
   - b. Use electronic mail on the Internet.
   - d. Utilize browsers to scan the Internet.

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ELT3.10 Voice, Data, and Video (Module 26310-11)
ELT4.5 Fire Alarm Systems (Module 26405-11)
EST2.8 Cable Selection (Module 33208-10)
EST2.9 Wire and Cable Terminations (Module 33209-10)
Course Name: Network Systems for Electrical Technology

Course Abbreviation: ELT 1544

Classification: Career, Technical, and Associate Elective

Description: Networking fundamentals, voice networking, LANs, and Internet. Also, upgrading of computers to support LAN technology (4 sch: 2-hr lecture, 4-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3) and AC/DC Circuit (ELT 1144) or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
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<tbody>
<tr>
<td>1. Demonstrate and practice general safety procedures in the school and work site environments. <strong>DOK1, ELT3.11, ELT4.7, EST3.5</strong></td>
</tr>
<tr>
<td>a. Apply relevant and appropriate safety techniques.</td>
</tr>
<tr>
<td>b. Demonstrate an understanding of and comply with relevant OSHA safety standards.</td>
</tr>
<tr>
<td>2. Discuss, describe, apply network fundamentals, and install network software used in the industrial manufacturing plants. <strong>DOK2, ELT3.11, ELT4.7, EST3.5</strong></td>
</tr>
<tr>
<td>a. Discuss the history of telecommunication’s networking.</td>
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<tr>
<td>b. Discuss the handling and routing of calls.</td>
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<tr>
<td>c. Discuss and/or define standards and terminology.</td>
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<tr>
<td>d. Discuss network architectures and OSI.</td>
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<tr>
<td>e. Discuss, define, and relate analog and digital signals to networking.</td>
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<tr>
<td>f. Discuss, describe, and relate transmission media to networking.</td>
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<tr>
<td>g. Prepare both network hardware and software for computer installation to PLC operation.</td>
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<tr>
<td>h. Identify proper card slots for hardware installation.</td>
</tr>
<tr>
<td>3. Discuss internetworking devices. <strong>DOK2, ELT3.11, ELT4.7, EST3.5</strong></td>
</tr>
<tr>
<td>a. Explain multiplexers.</td>
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<tr>
<td>b. Identify the uses of repeaters.</td>
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<tr>
<td>c. Examine the uses of PLC bridges and gateways.</td>
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<tr>
<td>d. Analyze the uses of hubs and switches.</td>
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<tr>
<td>e. Discuss wireless networking equipment.</td>
</tr>
<tr>
<td>4. Discuss and describe voice networks, and troubleshoot network communications interface. <strong>DOK1, ELT3.11, ELT4.7, EST3.5</strong></td>
</tr>
<tr>
<td>a. Discuss the public and private switching telephone network.</td>
</tr>
<tr>
<td>b. Discuss and describe voice processing and call distribution.</td>
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<tr>
<td>c. Discuss and describe T1 networks.</td>
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<tr>
<td>d. Discuss and describe virtual networks.</td>
</tr>
<tr>
<td>5. Discuss, install, and troubleshoot LANs. <strong>DOK2, ELT3.11, ELT4.7, EST3.5</strong></td>
</tr>
<tr>
<td>a. Discuss and describe LANs.</td>
</tr>
<tr>
<td>b. Discuss network software.</td>
</tr>
<tr>
<td>c. Install LAN system, and verify for operation.</td>
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<tr>
<td>d. Discuss and define network protocols.</td>
</tr>
<tr>
<td>6. Access the Internet. <strong>DOK1, ELT3.11, ELT4.7, EST3.5</strong></td>
</tr>
</tbody>
</table>
a. Discuss and interconnect with LANs.

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<th>Module</th>
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<td>ELT4.7</td>
<td>Advanced Controls (Module 26407-11)</td>
</tr>
<tr>
<td>EST3.5</td>
<td>Rack Assembly (Module 33305-11)</td>
</tr>
</tbody>
</table>
Course Name: Satellite Systems

Course Abbreviation: ELT 1553

Classification: Career, Technical, and Associate Elective

Description: Service, repair, and installation of residential and commercial satellite receiving systems and how they are used in the electrical industry (3 sch: 1-hr lecture, 4-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3) and AC/DC Circuits (ELT 1144) or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
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<tbody>
<tr>
<td>1. Demonstrate and practice general safety procedures in the school and work site environments.</td>
</tr>
<tr>
<td>a. Apply relevant and appropriate safety techniques.</td>
</tr>
<tr>
<td>b. Demonstrate an understanding of and comply with relevant OSHA safety standards.</td>
</tr>
<tr>
<td>2. Identify and describe the basic principles and types of satellite systems.</td>
</tr>
<tr>
<td>a. Describe the basic principles of satellite reception.</td>
</tr>
<tr>
<td>b. Identify the types of satellite systems, and describe their differences and functions.</td>
</tr>
<tr>
<td>3. Install, align, and service satellite systems in commercial and residential locations.</td>
</tr>
<tr>
<td>a. Determine best location, install, and align a satellite receiver for correct tracking.</td>
</tr>
<tr>
<td>b. Troubleshoot and repair faulty components in a satellite receiver system.</td>
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<tr>
<td>4. Identify specific NEC references for the use of satellite systems.</td>
</tr>
<tr>
<td>a. Look at the installation requirements for a satellite system.</td>
</tr>
<tr>
<td>b. Develop a detailed material list, and estimate for the installation of specific satellite systems.</td>
</tr>
</tbody>
</table>

STANDARDS

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ELT3.10 Voice, Data, and Video (Module 26310-11)
EST4.5 CCTV Systems (Module 33405-03)
EST4.6 Broadband Systems (Module 33406-03)
**Course Name:** Telephone Systems for Special Systems Electrical Technology

**Course Abbreviation:** ELT 1564

**Classification:** Career, Technical, and Associate Elective

**Description:** Information and hands-on experience in installation, operation, troubleshooting, and repair of residential- and commercial-use telephone systems, including analog and digital key systems (4 sch: 3-hr lecture, 2-hr lab)

**Prerequisite:** None

### Competencies and Suggested Objectives

<table>
<thead>
<tr>
<th>Competency</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Demonstrate and practice general safety procedures in the school and work site environments. DOK1, ELT3.10, ELT4.5, ELT4.7, EST4.6, EST4.11</td>
</tr>
<tr>
<td></td>
<td>a. Apply relevant and appropriate safety techniques.</td>
</tr>
<tr>
<td></td>
<td>b. Demonstrate an understanding of and comply with relevant OSHA safety standards.</td>
</tr>
<tr>
<td>2.</td>
<td>Explain and analyze the aspects of basic telephone service. DOK2, ELT3.10, ELT4.5, ELT4.7, EST4.6, EST4.11</td>
</tr>
<tr>
<td></td>
<td>a. Explain the principal parts of the telephone and the function of each.</td>
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<td></td>
<td>b. Analyze the characteristics of analog and digital signals.</td>
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<td></td>
<td>c. Explain the nationwide and worldwide numbering systems.</td>
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<td></td>
<td>d. Differentiate between landline and wireless telephone systems.</td>
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<td></td>
<td>e. Troubleshoot systems and their applications.</td>
</tr>
<tr>
<td>3.</td>
<td>Explain and test the operation and installation of key systems. DOK2, ELT3.10, ELT4.5, ELT4.7, EST4.6, EST4.11</td>
</tr>
<tr>
<td></td>
<td>a. Describe the key system advantages and components, and their functions, voltages, and operation.</td>
</tr>
<tr>
<td></td>
<td>b. Develop an installation plan to include results of the site survey, floor plans, set locations, equipment locations, list of materials, and costs.</td>
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<td></td>
<td>c. Identify, interpret, and develop a blueprint using symbols for telephone system installation.</td>
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<td>d. Install a key security system using the proper tools following manufacturer’s specifications, proper grounding procedures, and all applicable safety practices.</td>
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<td>e. Identify malfunctions in the key security system using approved troubleshooting procedures, and make repairs as necessary.</td>
</tr>
<tr>
<td>4.</td>
<td>Explain and test the operation and installation of digital key systems. DOK2, ELT3.10, ELT4.5, ELT4.7, EST4.6, EST4.11</td>
</tr>
<tr>
<td></td>
<td>a. Identify and describe the advantages and components and their functions, voltages, and operation.</td>
</tr>
<tr>
<td></td>
<td>b. Describe the uses and limitations of block diagrams as they relate to installation.</td>
</tr>
<tr>
<td></td>
<td>c. Explain and define the use and interconnection of data communications systems with a digital key system to include fiber interface, ISDN, and T-1s.</td>
</tr>
<tr>
<td></td>
<td>d. Explain and outline network protocol as it pertains to the digital key system interaction with data communications networks.</td>
</tr>
<tr>
<td></td>
<td>e. Develop an installation plan to include results of the site survey, floor plans, set locations, equipment locations, list of materials, and costs.</td>
</tr>
</tbody>
</table>
f. Install a key system using the proper tools following manufacturer’s specifications, proper grounding procedures, and all applicable safety practices.
g. Identify malfunctions in the digital key system using approved troubleshooting procedures, and make necessary repairs.

5. Install a telephone system as per applicable codes.  
a. Explain the relevant NEC and other codes used in telephone systems.  
b. Design, install, and maintain raceways systems for telephone systems.

6. Demonstrate the ability to properly terminate a telephone system.  
a. Use the system proper system tools to terminate telephone systems.  
b. Follow proper codes and standards while terming a telephone system.

7. Install various special electrical systems used in the construction process, and follow all applicable codes and standards. 
a. Install a nurse call system.  
b. Install a fire alarm system.  
c. Install a security system.

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ELT3.10 Voice, Data, and Video (Module 26310-11)  
ELT4.5 Fire Alarm Systems (Module 26405-11)  
ELT4.7 Advanced Controls (Module 26407-11)  
EST4.6 Broadband Systems (Module 33406-03)  
EST4.11 Telecommunications Systems (Module 33411-05)
Course Name: Principles of Hydraulics and Pneumatics

Course Abbreviation: ELT 1614

Classification: Career Elective (Certificate); Technical and Associate Core (Degree)

Description: Instruction in basic principles of hydraulics and pneumatics and the inspection, maintenance, and repair of hydraulic and pneumatic systems (4 sch: 1 hr lecture, 6 hr lab) [May be taught as a 90-contact-hour lab in open-entry/open-exit career programs]

Prerequisite: None

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Describe and discuss basic principles of hydraulics as related to industrial maintenance. DOK1, IMM3.11</td>
</tr>
<tr>
<td>a. Identify the basic components of a hydraulic system, including fluids, filters, pumps, lines, control valves, cylinders, motors, and so forth.</td>
</tr>
<tr>
<td>b. Interpret schematics of hydraulic systems.</td>
</tr>
<tr>
<td>c. Differentiate between open and closed hydraulic systems.</td>
</tr>
<tr>
<td>d. Practice safety precautions and procedures associated with hydraulic systems.</td>
</tr>
<tr>
<td>2. Inspect, maintain, and repair hydraulic systems. DOK2, IMM3.11</td>
</tr>
<tr>
<td>a. Evaluate hydraulic pumps for pressure and flow.</td>
</tr>
<tr>
<td>b. Inspect hydraulic valves for leakage and proper actions.</td>
</tr>
<tr>
<td>c. Inspect hydraulic cylinders for leakage and proper operations.</td>
</tr>
<tr>
<td>3. Describe and discuss basic principles of pneumatics as associated with industrial maintenance. DOK1, IMM3.12</td>
</tr>
<tr>
<td>a. Identify the components of a pneumatic system, including compressor, lines, control valves, gauges, filters, attachments, cylinders, and motors.</td>
</tr>
<tr>
<td>b. Interpret schematics of pneumatic systems.</td>
</tr>
<tr>
<td>c. Practice safety precautions and procedures associated with pneumatic systems.</td>
</tr>
<tr>
<td>4. Inspect, maintain, and repair pneumatic systems. DOK1, IMM3.12</td>
</tr>
<tr>
<td>a. Perform scheduled preventive maintenance on an air compressor.</td>
</tr>
<tr>
<td>b. Evaluate pneumatic equipment and devices for leakage and proper operation.</td>
</tr>
</tbody>
</table>

STANDARDS

National Center for Construction Education and Research Standards

IMM3.11 Hydraulic Controls (Module 40311-09)
IMM3.12 Pneumatic Controls (Module 40312-09)
Course Name: Equipment Maintenance, Troubleshooting, and Repair

Course Abbreviation: ELT 2114

Classification: Career Elective (Certificate); Technical and Associate Core (Degree)

Description: Maintenance and troubleshooting techniques, use of technical manuals and test equipment, and inspection/evaluation/repair of equipment (4 sch: 1hr lecture, 6hr lab)

Prerequisite: None

Competencies and Suggested Objectives

| 1. Discuss and apply proper safety procedures regarding maintenance, troubleshooting, and repair of equipment. | DOK1, ELT4.8, IMM3.11, IMM3.12 |
| 2. Perform preventive maintenance on equipment. | DOK2, ELT4.8, IMM3.11, IMM3.12 |
| a. Develop a preventive maintenance program for a given piece of equipment. |
| b. Inspect and adjust belts, chains, and other moving parts. |
| c. Lubricate a machine following manufacturer’s recommendations. |
| 3. Troubleshoot and repair equipment. | DOK2, ELT4.8, IMM3.11, IMM3.12 |
| a. Identify symptoms that indicate a machine is not operating properly (excessive noise, vibration, heat, speed, etc.). |
| b. Determine the cause of the symptoms. |
| c. Inspect machinery for broken or worn parts, and determine if replacement is needed. |
| d. Prepare a report on time and costs involved in repairing equipment. |
| e. Perform tagout-lockout procedures for broken equipment. |
| f. Disassemble, inspect, repair, and reassemble equipment to specifications. |
| g. Perform preventive maintenance on an electric motor (disassemble, clean and inspect, repair mechanical components, lubricate, and reassemble). |
| h. Check and service a battery, including recharging. |
| 4. Estimate expenses for a given project. | DOK1, ELT4.8, IMM3.11, IMM3.12 |
| a. Prepare a bill of materials list for a specific job. |
| b. Calculate the labor factor for a specific job. |

STANDARDS

National Center for Construction Education and Research Standards

ELT4.8 HVAC Controls (Module 26408-11)
IMM3.11 Hydraulic Controls (Module 40311-09)
IMM3.12 Pneumatic Controls (Module 40312-09)
Course Name: Introduction to Sustainable and Renewable Energy

Course Abbreviation: ELT 2213

Classification: Career, Technical, and Associate Elective

Description: An introduction to alternative energy sources, such as wind, solar, bloom, wave, and hydroelectric applications. Installation techniques and power-transfer methods are also taught. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Fundamentals of Electricity (ELT 1192-3), AC/DC Circuits (ELT 1144), and Residential/Light Commercial Wiring (ELT 1113) or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Apply general safety and safety requirements for working on and around electrical motors. DOK1, ELT4.7</td>
</tr>
<tr>
<td>a. Apply principles of safety in the use of electrical equipment and components.</td>
</tr>
<tr>
<td>b. Describe safety procedures to utilize during connecting and operating electrical equipment.</td>
</tr>
<tr>
<td>2. Identify and explain different types of sustainable and renewable energy and the equipment needed in each process. DOK1, ELT4.7</td>
</tr>
<tr>
<td>a. Wind</td>
</tr>
<tr>
<td>b. Solar</td>
</tr>
<tr>
<td>c. Bloom</td>
</tr>
<tr>
<td>d. Wave Technology</td>
</tr>
<tr>
<td>e. Hydro Electric</td>
</tr>
<tr>
<td>3. Demonstrate and explain the proper procedures for locating and installing sustainable and renewable energy devices. DOK1, ELT4.7</td>
</tr>
<tr>
<td>a. Wind</td>
</tr>
<tr>
<td>b. Solar</td>
</tr>
<tr>
<td>4. Demonstrate and explain proper method of integrating power to the grid. DOK2, ELT4.7</td>
</tr>
<tr>
<td>a. Transfer switches/Sub-panels</td>
</tr>
<tr>
<td>b. Inverters</td>
</tr>
<tr>
<td>c. Voltage regulators</td>
</tr>
<tr>
<td>d. Battery banks.</td>
</tr>
</tbody>
</table>

STANDARDS

National Center for Construction Education and Research Standards

ELT4.7 Advanced Controls (Module 26407-11)
Course Name: Solid State Motor Control

Course Abbreviation: ELT 2424

Classification: Career Elective (Certificate); Technical and Associate Core (Degree)

Description: Principles and operation of solid state motor control. Also, the design, installation, and maintenance of different solid state devices for motor control (4 sch: 2-hr lecture, 4-hr lab).

Prerequisite: Motor Control Systems (ELT 1413) and Programmable Logic Controllers (ELT 2613) or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Apply general safety and safety requirements for working on and around electrical motors. DOK1, ELT4.7</td>
</tr>
<tr>
<td>a. Apply principles of safety in the use of electrical motors.</td>
</tr>
<tr>
<td>b. Describe safety procedures to utilize during connecting and operating electric motors.</td>
</tr>
<tr>
<td>2. Troubleshoot solid state motor controls. DOK2, ELT4.7</td>
</tr>
<tr>
<td>a. Identify electronic and industrial symbols used to represent logic gates in solid state schematics.</td>
</tr>
<tr>
<td>b. Describe the operation of the different types of industrial and electronic logic gates.</td>
</tr>
<tr>
<td>c. Draw a solid state logic circuit to replace a manual control station.</td>
</tr>
<tr>
<td>d. Troubleshoot and repair/replace solid state devices to include memory devices, flip/flops, adjustable time delays, starting and stopping sequences, and looping.</td>
</tr>
<tr>
<td>3. Operate AC and DC variable speed drives. DOK2, ELT4.7</td>
</tr>
<tr>
<td>a. Discuss the operation of a DC variable speed drive.</td>
</tr>
<tr>
<td>b. Discuss the operation of an AC variable speed drive.</td>
</tr>
<tr>
<td>c. Connect and operate a DC and AC variable speed drive.</td>
</tr>
</tbody>
</table>

STANDARDS

National Center for Construction Education and Research Standards

ELT4.7 Advanced Controls (Module 26407-11)
Course Name: Programmable Logic Controllers

Course Abbreviation: ELT 2613

Classification: Career Elective (Certificate); Technical and Associate Core (Degree)

Description: Use of programmable logic controllers (PLCs) in modern industrial settings. Also, the operating principles of PLCs and practice in the programming, installation, and maintenance of PLCs (3 sch: 2-hr lecture, 2-hr lab.).

Prerequisite: Motor Control Systems (ELT 1413) or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
<th>DOK1, ELT3.11, ELT4.6, ELT4.7, ELT4.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Explain principles of PLCs.</td>
<td>DOK1, ELT3.11, ELT4.6, ELT4.7, ELT4.8</td>
</tr>
<tr>
<td>a. Identify components and operational principles of PLCs.</td>
<td></td>
</tr>
<tr>
<td>b. Differentiate between a PLC and a computer.</td>
<td></td>
</tr>
<tr>
<td>2. Identify different types of PLC hardware.</td>
<td>DOK1, ELT3.11, ELT4.6, ELT4.7, ELT4.8</td>
</tr>
<tr>
<td>a. Identify and wire different types of input and output modules.</td>
<td></td>
</tr>
<tr>
<td>b. Identify different types of PLC processor modules, memory capabilities, and programming devices.</td>
<td></td>
</tr>
<tr>
<td>3. Explain numbering systems, encoding/decoding, and logical operations.</td>
<td>DOK1, ELT3.11, ELT4.6, ELT4.7, ELT4.8</td>
</tr>
<tr>
<td>a. Convert numbers from one system to another.</td>
<td></td>
</tr>
<tr>
<td>b. Explain logical operations using truth tables and ladder logic diagrams.</td>
<td></td>
</tr>
<tr>
<td>4. Program all types of internal and discrete instructions.</td>
<td>DOK2, ELT3.11, ELT4.6, ELT4.7, ELT4.8</td>
</tr>
<tr>
<td>a. Program examine on and off instructions.</td>
<td></td>
</tr>
<tr>
<td>b. Program on-delay and off-delay instructions.</td>
<td></td>
</tr>
<tr>
<td>c. Program up-counter and down-counter instructions.</td>
<td></td>
</tr>
<tr>
<td>d. Program sequencer instructions for real-world output devices.</td>
<td></td>
</tr>
<tr>
<td>e. Program latch and unlatch instructions.</td>
<td></td>
</tr>
<tr>
<td>5. Troubleshoot and maintain different programmable controllers systems.</td>
<td>DOK1, ELT3.11, ELT4.6, ELT4.7, ELT4.8</td>
</tr>
<tr>
<td>a. Identify and troubleshoot the power supply.</td>
<td></td>
</tr>
<tr>
<td>b. Identify and troubleshoot the inputs and outputs (I/O) cards.</td>
<td></td>
</tr>
<tr>
<td>c. Identify and troubleshoot real-world inputs and outputs.</td>
<td></td>
</tr>
</tbody>
</table>

STANDARDS

National Center for Construction Education and Research Standards

ELT3.11 Motor Controls (Module 26311-11)
ELT4.6 Specialty Transformers (Module 26406-11)
ELT4.7 Advanced Controls (Module 26407-11)
ELT4.8 HVAC Controls (Module 26408-11)
Course Name: Advanced Programmable Logic Controllers

Course Abbreviation: ELT 2623

Classification: Career, Technical, and Associate Elective

Description: Advanced PLC course that provides instruction in the various operations, installations, and maintenance of electric motor controls. Also, information in such areas as sequencer, program control, introduction to function blocks, sequential function chart, introduction to HMI, and logical and conversion instructions (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Programmable Logic Controllers (ELT 2613) and Motor Control Systems (ELT 1413) or by permission of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Program all types of high order instructions.</td>
</tr>
<tr>
<td>a. Calculate and develop mathematical instructions to include addition, subtraction, multiplication, and division.</td>
</tr>
<tr>
<td>b. Program and set up a chart for input and output sequencer combination.</td>
</tr>
<tr>
<td>c. Program and set up an analog input and output card using PLC software.</td>
</tr>
<tr>
<td>d. Explain the use of function block and sequential function blocks in a programmable logic controller.</td>
</tr>
<tr>
<td>e. Demonstrate the ability to develop a basic Human to Machine Interface (HMI) project.</td>
</tr>
<tr>
<td>f. Program and demonstrate how to set up a produce and consume tag/message.</td>
</tr>
<tr>
<td>2. Troubleshoot advanced PLC controls.</td>
</tr>
<tr>
<td>a. Troubleshoot an analog input and output card.</td>
</tr>
<tr>
<td>b. Troubleshoot communication devices used in networking.</td>
</tr>
</tbody>
</table>

STANDARDS

National Center for Construction Education and Research Standards

ELT3.11 Motor Controls (Module 26311-11)
ELT4.6 Specialty Transformers (Module 26406-11)
ELT4.7 Advanced Controls (Module 26407-11)
ELT4.8 HVAC Controls (Module 26408-11)
Course Name: Special Project I, II

Course Abbreviation: ELT 291(1-3), ELT 293(1-3)

Classification: Career, Technical, and Associate Elective

Description: Practical application of skills and knowledge gained in other electrical or electrical-related technical courses. The instructor works closely with the student to ensure that the selection of a project will enhance the student’s learning experience. (1–3 sch: 2–6-hr lab)

Prerequisite: Consent of instructor

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Develop a written plan and blueprints that detail the activities and projects to be completed.</td>
</tr>
<tr>
<td>a. Utilize a written plan that details the activities and projects to be completed.</td>
</tr>
<tr>
<td>b. Perform written occupational objectives in the special project.</td>
</tr>
<tr>
<td>2. Assess accomplishment of objectives.</td>
</tr>
<tr>
<td>a. Prepare daily written assessment of accomplishment of objectives.</td>
</tr>
<tr>
<td>b. Present weekly written reports to the instructor in activities performed and objectives accomplished.</td>
</tr>
<tr>
<td>3. Utilize a set of written guidelines for the special project.</td>
</tr>
<tr>
<td>a. Develop and follow a set of written guidelines for the special project.</td>
</tr>
</tbody>
</table>

STANDARDS

Specific standards for this course will depend upon the nature of the problem under investigation.
Course Name: Supervised Work Experience I, II
Course Abbreviation: ELT 292(1-6), ELT 294(1-6)

Classification: Career, Technical, and Associate Elective

Description: A cooperative program between industry and education that is designed to integrate the student’s technical studies with industrial experience. Variable credit is awarded on the basis of 1 semester credit hour (sch) per 45 industrial contact hours. (1–6 sch: 3–18-hr externship)

Prerequisite: Consent of instructor and completion of at least one semester of advanced coursework in electrical/electronics related programs

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
</table>
| 1. Apply technical skills needed to be a viable member of the workforce.  
  a. Prepare a description of technical skills to be developed in the supervised work experience program.  
  b. Develop technical skills needed to be a viable member of the workforce.  
| 2. Apply skills developed in other program area courses.  
  a. Perform skills developed in other program area courses in the supervised work experience program.  
| 3. Apply human relationship skills.  
  a. Practice human relationship skills in the supervised work experience program.  
| 4. Apply and practice positive work habits and responsibilities.  
  a. Perform assignments to develop positive work habits and responsibilities.  
| 5. Work with the instructor and employer to develop written occupational objectives to be accomplished.  
  a. Perform written occupational objectives in the supervised occupational experience program.  
| 6. Assess accomplishment of objectives.  
  a. Prepare daily written assessment of accomplishment of objectives.  
  b. Present weekly written reports to instructor in activities performed and objectives accomplished.  
| 7. Utilize a set of written guidelines for the supervised work experience.  
  a. Develop and follow a set of written guidelines for the supervised work experience.  

STANDARDS

Specific standards for this course will depend upon the nature of the problem under investigation.
Course Name: Fundamentals of Construction and Manufacturing

Course Abbreviation: CTE 1143

Classification: Career, Technical, and Associate Core/Elective (This course may be taught as an elective or a core course. Please refer to the course sequence in the appropriate curriculum to determine the classification of this course.)

Description: This course includes basic safety, an introduction to construction math, an introduction to hand and power tools, an introduction to construction drawings, employability skills and communications. (Approximately 72.5 clock hours should be allotted in this course to satisfy requirements to test for NCCER Core certification. Instructors for this course must be certified as an NCCER Instructor.) (3 sch: 2 hr. lecture, 2 hr. lab)

Prerequisites: None

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Competencies and Suggested Objectives</strong></td>
</tr>
<tr>
<td>1. Describe general safety rules for working in a shop/lab and industry.</td>
</tr>
<tr>
<td>a. Describe how to avoid on-site accidents.</td>
</tr>
<tr>
<td>b. Explain the relationship between housekeeping and safety.</td>
</tr>
<tr>
<td>c. Explain the importance of following all safety rules and company safety policies according to OSHA standards including addressing General Duty Clause and 1926 CFR Subpart C.</td>
</tr>
<tr>
<td>d. Explain the importance of reporting all on-the-job injuries, accidents, and near misses.</td>
</tr>
<tr>
<td>e. Explain the need for evacuation policies and the importance of following them.</td>
</tr>
<tr>
<td>f. Explain the employer’s substances abuse policy and how it relates to safety.</td>
</tr>
<tr>
<td>g. Explain the safety procedures when working near pressurized or high temperature.</td>
</tr>
<tr>
<td>h. Use proper safety practices when working around welding operations.</td>
</tr>
<tr>
<td>i. Use proper safety practices when working in or near trenches and excavations.</td>
</tr>
<tr>
<td>j. Explain the term proximity work.</td>
</tr>
<tr>
<td>2. Identify and explain use of various barriers and confinements</td>
</tr>
<tr>
<td>a. Explain the safety requirements for working in confined areas.</td>
</tr>
<tr>
<td>b. Explain and practice lockout/tagout procedures.</td>
</tr>
<tr>
<td>c. Explain the different barriers and barricades, and how they are used.</td>
</tr>
<tr>
<td>d. Recognize and explain personal protective equipment.</td>
</tr>
<tr>
<td>e. Inspect and care for personal protective equipment.</td>
</tr>
<tr>
<td>3. Explain lifting, fall protection, and the use of ladders and scaffolds.</td>
</tr>
<tr>
<td>a. Identify and explain the procedures for lifting heavy objects.</td>
</tr>
<tr>
<td>b. Explain fall protection procedures.</td>
</tr>
<tr>
<td>c. Inspect and safely work with various ladders and scaffolds.</td>
</tr>
<tr>
<td>4. Explain the Material Safety Data Sheet (MSDS).</td>
</tr>
<tr>
<td>a. Explain the function of the MSDS.</td>
</tr>
<tr>
<td>b. Interpret the requirements of the MSDS.</td>
</tr>
<tr>
<td>c. Discuss hazardous material exposures.</td>
</tr>
<tr>
<td>5. Display appropriate safety procedures related to fires.</td>
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<tr>
<td>Task</td>
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</tbody>
</table>

**OPTIONAL COMPETENCY:**
13. Explain and identify safe rigging and equipment.
STANDARDS

NCCER Learning Series Standards

NCCER Core

BSM – BASIC SAFETY (00101-09)
ICM – INTRODUCTION TO CONSTRUCTION MATH (00102-09)
IHT – INTRODUCTION TO HAND TOOLS (00103-09)
IPT – INTRODUCTION TO POWER TOOLS (00104-09)
BLU – INTRODUCTION TO CONSTRUCTION DRAWINGS (00105-09)
COM – BASIC COMMUNICATION SKILLS (00107-09)
EMP – BASIC EMPLOYABILITY SKILLS (00108-09)
IMH – INTRODUCTION TO MATERIALS HANDLING (00109-09)
RIG – BASIC RIGGING (00106-09)
Course Name: Computational Methods for Career and Technical Education

Course Abbreviation: CTE 1153

Classification: Career, Technical, and Associate Elective

Description: Study of computational skills required for the development of accurate design and drafting methods used in technology based professions. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: None

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Demonstrate various measurement methods. DOK1</td>
</tr>
<tr>
<td>a. Measure distances, including metric and English measurements.</td>
</tr>
<tr>
<td>b. Measure angles, including decimal degrees and degrees, minutes, and seconds.</td>
</tr>
<tr>
<td>2. Apply industry data. DOK2</td>
</tr>
<tr>
<td>a. Interpret graphs and charts.</td>
</tr>
<tr>
<td>b. Manipulate gathered information.</td>
</tr>
<tr>
<td>3. Analyze complex geometric shapes. DOK2</td>
</tr>
<tr>
<td>a. Calculate area using metric and English systems.</td>
</tr>
<tr>
<td>b. Calculate volume using metric and English systems.</td>
</tr>
<tr>
<td>c. Solve geometric construction based on area/volume solutions.</td>
</tr>
<tr>
<td>4. Calculate trigometric values. DOK2</td>
</tr>
<tr>
<td>a. Calculate angle values of a triangle.</td>
</tr>
<tr>
<td>b. Solve geometric construction based on angular solutions.</td>
</tr>
<tr>
<td>5. Calculate industry expenses. DOK2</td>
</tr>
<tr>
<td>a. Prepare a cost analysis.</td>
</tr>
<tr>
<td>b. Compute overhead expenses.</td>
</tr>
<tr>
<td>6. General mathematics. DOK2</td>
</tr>
<tr>
<td>a. Use a calculator.</td>
</tr>
<tr>
<td>b. Solve basic algebraic equations and conversions from fraction to decimal and metric.</td>
</tr>
</tbody>
</table>

STANDARDS

Specific standards will be determined by the national standards aligned to the individual program area utilizing this course.

SUGGESTED REFERENCES

References will be determined by content unique to the program area utilizing this course.
Course Name: Introduction to Sustainable and Renewable Energy

Course Abbreviation: CTE 1163

Classification: Career, Technical, and Associate Elective

Description: An introduction to alternative energy sources, such as wind, solar, bloom, wave, and hydroelectric applications. Installation techniques and power-transfer methods are also taught. (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: None

<table>
<thead>
<tr>
<th>Competencies and Suggested Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Apply general safety and safety requirements for working on and around electrical motors. (^{DOK1})</td>
</tr>
<tr>
<td>a. Apply principles of safety in the use of electrical equipment and components.</td>
</tr>
<tr>
<td>b. Describe safety procedures to utilize during connecting and operating electrical equipment.</td>
</tr>
<tr>
<td>2. Identify and explain different types of sustainable and renewable energy and the equipment needed in each process. (^{DOK1})</td>
</tr>
<tr>
<td>a. Wind</td>
</tr>
<tr>
<td>b. Solar</td>
</tr>
<tr>
<td>c. Bloom</td>
</tr>
<tr>
<td>d. Wave Technology</td>
</tr>
<tr>
<td>e. Hydro Electric (^{DOK1})</td>
</tr>
<tr>
<td>3. Demonstrate and explain the proper procedures for locating and installing sustainable and renewable energy devices. (^{DOK17})</td>
</tr>
<tr>
<td>a. Wind</td>
</tr>
<tr>
<td>b. Solar</td>
</tr>
<tr>
<td>4. Demonstrate and explain proper method of integrating power to the grid. (^{DOK2})</td>
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<td>a. Transfer switches/Sub-panels</td>
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<td>b. Inverters</td>
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<tr>
<td>c. Voltage regulators</td>
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<tr>
<td>d. Battery banks</td>
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STANDARDS

Specific standards will be determined by the national standards aligned to the individual program area utilizing this course.

SUGGESTED REFERENCES

References will be determined by content unique to the program area utilizing this course.
Appendix A: Course References

All of the Electrical Technology courses use the same resources for each course. You will find suggested resources listed below.

ELT 1113


ELT 1123


**ELT 1133**


**ELT 1144**


**ELT 1163**


**ELT 1192-3**


**ELT 1213**


**ELT 1223**


**ELT 1253 Branch Circuit and Service Entrance Calculations**


**ELT 1263 Blueprint Reading/Planning in Residential Installation**


**ELT 1273 Switching Circuits for Residential, Commercial, and Industrial Applications**


**ELT 1283 Estimating the Cost of an Electrical Installation**


**ELT 1313 Automated Manufacturing Controls for Electrical Technology**


ELT 1324 Calibration and Measurement Principles Used in the Electrical Industry


ELT 1334 Flexible Manufacturing Systems for Electrical Technology


**ELT 1343 Fundamentals of Instrumentation**


**ELT 1334 Flexible Manufacturing Systems for Electrical Technology**


**ELT 1353 Fundamentals of Robotics for Electrical Technology**


ELT 1363 Industrial Hydraulics for Electrical Technology


ELT 1373 Industrial Pneumatics for Electrical Technology


ELT 1383 Industrial Robotics for Electrical Technology


**ELT 1393 Servo Control Systems for Electrical Technology**


**ELT 1413 Motor Control Systems**


ELT 1434 Solid State Devices and Circuits for Electrical Technology


ELT 1513 Data Acquisition and Communications


ELT 1523 Fundamentals of Fiber Optics for Electrical Technology


ELT 1533 Fundamentals of Data Communications for Electrical Technology


ELT 1544 Network Systems for Electrical Technology


ELT 1553 Satellite Systems


ELT 1564 Telephone Systems for Special Systems Electrical Technology


ELT 1614 Principles of Hydraulics and Pneumatics


ELT 2113-4 Equipment Maintenance, Troubleshooting, and Repair


ELT 2424 Solid State Motor Control


ELT 2613 Programmable Logic Controllers


**ELT 2623 Advanced Programmable Logic Controllers**


Appendix B: Standards for the NCCER

NCCER Electrician

ELT1.1 Orientation to the Electrical Trade (Module 26101-11)
ELT1.2 Electrical Safety (Module 26102-11)
ELT1.3 Introduction to Electrical Circuits (Module 26103-11)
ELT1.4 Electrical Theory (Module 26104-11)
ELT1.5 Introduction to the National Electrical Code (Module 26105-11)
ELT1.6 Device Boxes (Module 26106-11)
ELT1.7 Hand Bending (Module 26107-11)
ELT1.8 Raceways and Fittings (Module 26108-11)
ELT1.9 Conductors and Cables (Module 26109-11)
ELT1.10 Basic Electrical Construction Drawings (Module 26110-11)
ELT1.11 Residential Electrical Services (Module 26111-11)
ELT1.12 Electrical Test Equipment (Module 26112-11)

ELT2.1 Alternating Current (Module 26201-11)
ELT2.2 Motors: Theory and Application (Module 26202-11)
ELT2.3 Electric Lighting (Module 26203-11)
ELT2.4 Conduit Bending (Module 26204-11)
ELT2.5 Pull and Junction Boxes (Module 26205-11)
ELT2.6 Conductor Installations (Module 26206-11)
ELT2.7 Cable Tray (Module 26207-11)
ELT2.8 Conductor Terminations and Splices (Module 26208-11)
ELT2.9 Grounding and Bonding (Module 26209-11)
ELT2.10 Circuit Breakers and Fuses (Module 26210-11)
ELT2.11 Control Systems and Fundamental Concepts (Module 26211-11)

ELT3.1 Load Calculations – Branch and Feeder Circuits (Module 26301-11)
ELT3.2 Conductor Selection and Calculations (Module 26302-11)
ELT3.3 Practical Applications of Lighting (Module 26303-11)
ELT3.4 Hazardous Locations (Module 26304-11)
ELT3.5 Overcurrent Protection (Module 26305-11)
ELT3.6 Distribution Equipment (Module 26306-11)
ELT3.7 Transformers (Module 26307-11)
ELT3.8 Commercial Electrical Services (Module 26308-11)
ELT3.9 Motor Calculations (Module 26309-11)
ELT3.10 Voice, Data, and Video (Module 26310-11)
ELT3.11 Motor Controls (Module 26311-11)

ELT4.1 Load Calculations – Feeders and Services (Module 26401-11)

ELT4.2 Health Care Facilities (Module 26402-11)
ELT4.3 Standby and Emergency Systems (Module 26403-11)
ELT4.4 Basic Electronic Theory (Module 26404-11)
ELT4.5 Fire Alarm Systems (Module 26405-11)
ELT4.6 Specialty Transformers (Module 26406-11)
ELT4.7 Advanced Controls (Module 26407-11)
ELT4.8 HVAC Controls (Module 26408-11)
ELT4.9 Heat Tracing and Freeze Protection (Module 26409-11)
ELT4.10 Motor Operation and Maintenance (Module 26410-11)
ELT4.11 Medium-Voltage Terminations/Splices (Module 26411-11)
ELT4.12 Special Locations (Module 26412-11)

**NCCER Instrumentation**

INS1.1 Hand Tools for Instrumentation (Module 12101-01)
INS1.2 Electrical Safety (Module 12102-01)
INS1.3 Power Tools for Instrumentation (Module 12103-01)
INS1.4 Electrical Systems for Instrumentation (Module 12104-01)
INS1.5 Metallurgy for Instrumentation (Module 12105-01)
INS1.6 Fasteners (Module 12106-01)
INS1.7 Instrumentation Drawings and Documents, Part One (Module 12107-01)
INS1.8 Gaskets and Packing (Module 12108-01)
INS1.9 Lubricants, Sealants, and Cleaners (Module 12109-01)
INS1.10 Flow, Pressure, Level, and Temperature (Module 12110-01)
INS1.11 Tubing (Module 12111-01)
INS1.12 Piping - 2 in. and Under (Module 12112-01)
INS1.13 Hoses (Module 12113-01)

INS2.1 Craft-Related Mathematics (Module 12201-03)
INS2.2 Instrumentation Drawings and Documents, Part Two (Module 12202-03)
INS2.3 Principles of Welding for Instrumentation (Module 12203-03)
INS2.4 Process Control Theory (Module 12204-03)
INS2.5 Detectors, Secondary Elements, Transducers, and Transmitters (Module 12205-03)
INS2.6 Controllers, Recorders, and Indicators (Module 12206-03)
INS2.7 Control Valves, Actuators, and Positioners (Module 12207-03)
INS2.8 Relays and Timers (Module 12208-03)
INS2.9 Switches and Photoelectric Devices (Module 12209-03)
INS2.10 Filters, Regulators, and Dryers (Module 12210-03)
INS2.11 Analyzers and Monitors (Module 12211-03)
INS2.12 Panel-Mounted Instruments (Module 12212-03)
INS2.13 Installing Field-Mounted Instruments (Module 12213-03)
INS2.14 Raceways for Instrumentation (Module 12214-03)
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## NCCER Electronic Systems Technician

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EST4.4 Overview of Nurse Call and Signaling Systems (Module 33404-03)
EST4.5 CCTV Systems (Module 33405-03)
EST4.6 Broadband Systems (Module 33406-03)
EST4.7 Access Control Systems (Module 33407-03)
EST4.8 Systems Integration (Module 33408-03)
EST4.10 Media Management Systems (Module 33410-03)
EST4.11 Telecommunications Systems (Module 33411-05)
### Appendix C: Related Academic Standards

#### Related Academic Standards

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### Related Academic Standards

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Reading
R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)

Mathematics Computation
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations

Applied Mathematics
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)

Language
L1 Usage (pronoun, tense, subject/verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)

Spelling
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)
## Appendix D: 21st Century Skills

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### CS1 Global Awareness
1. Using 21st century skills to understand and address global issues
2. Learning from and working collaboratively with individuals representing diverse cultures, religions and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
3. Understanding other nations and cultures, including the use of non-English languages

### CS2 Financial, Economic, Business and Entrepreneurial Literacy
1. Knowing how to make appropriate personal economic choices
2. Understanding the role of the economy in society
3. Using entrepreneurial skills to enhance workplace productivity and career options

### CS3 Civic Literacy
1. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
2. Exercising the rights and obligations of citizenship at local, state, national and global levels
3. Understanding the local and global implications of civic decisions
CS4 Health Literacy
1. Obtaining, interpreting and understanding basic health information and services and using such information and services in ways that enhance health
2. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
3. Using available information to make appropriate health-related decisions
4. Establishing and monitoring personal and family health goals
5. Understanding national and international public health and safety issues

CS5 Environmental Literacy
1. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water and ecosystems
2. Demonstrate knowledge and understanding of society’s impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
3. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
4. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

CS6 Creativity and Innovation
1. Think Creatively
2. Work Creatively with Others
3. Implement Innovations

CS7 Critical Thinking and Problem Solving
1. Reason Effectively
2. Use Systems Thinking
3. Make Judgments and Decisions
4. Solve Problems

CS8 Communication and Collaboration
1. Communicate Clearly
2. Collaborate with Others

CS9 Information Literacy
1. Access and Evaluate Information
2. Use and Manage Information

CS10 Media Literacy
1. Analyze Media
2. Create Media Products

CS11 ICT Literacy
1. Apply Technology Effectively

CS12 Flexibility and Adaptability
1. Adapt to change
2. Be Flexible

CS13 Initiative and Self-Direction
1. Manage Goals and Time
2. Work Independently
3. Be Self-directed Learners

CS14 Social and Cross-Cultural Skills
1. Interact Effectively with others
2. Work Effectively in Diverse Teams

CS15 Productivity and Accountability
1. Manage Projects
2. Produce Results

CS16 Leadership and Responsibility
1. Guide and Lead Others
2. Be Responsible to Others