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Electrical Technology
Mississippi Curriculum Framework

Program CIP: 46.0302 – Electrician

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The Office of Curriculum and Instruction (OCI) was founded in 2013 under the Division of Workforce, Career, and Technical Education at the Mississippi Community College Board (MCCB). The office is funded through a partnership with The Mississippi Department of Education (MDE), who serves as Mississippi's fiscal agent for state and federal Career and Technical Education (CTE) Funds. The OCI is tasked with developing statewide CTE curriculum, programming, and professional development designed to meet the local and statewide economic demand.

CONTENTS

ADOPTION OF NATIONAL CERTIFICATION STANDARDS

The National Center for Construction Education and Research (NCCER) a not-for-profit 501(c)(3) education foundation created in 1996. It was developed with the support of more than 125 construction CEOs and various association and academic leaders who united to revolutionize training for the construction industry. Sharing the common goal of developing a safe and productive workforce, these companies created a standardized training and credentialing program for the industry. This progressive program has evolved into curricula for more than 70 craft areas and a complete series of more than 70 assessments offered in over 4,000 NCCER-accredited training and assessment locations across the United States.

NCCER develops standardized construction and maintenance curricula and assessments with portable credentials. These credentials are tracked through NCCER's National Registry which allows organizations and companies to track the qualifications of their craft professionals and/or check the qualifications of possible new hires. The National Registry also assists craft professionals by maintaining their records in a secure database.

NCCER's process of accreditation, instructor certification, standardized curriculum, national registry, assessment, and certification is a key component in the industry's workforce development efforts. NCCER also drives multiple initiatives to enhance career development and recruitment efforts for the industry. NCCER is headquartered in Alachua, Fla., and is affiliated with the University of Florida's M.E. Rinker, Sr. School of Building Construction.

As the accrediting body for the industry, NCCER establishes the benchmark for quality training and assessments. By partnering with industry and academia, NCCER has developed a system for program accreditation that is similar to those found in institutions of higher learning. This process fosters national unity among the construction industry while providing a defined career path with industry-recognized credentials.

NCCER's accreditation process assures that students and craft professionals receive quality training based on uniform standards and criteria. These standards are outlined in the NCCER Accreditation Guidelines and must be adhered to by all NCCER Accredited Training Sponsors and Accredited Assessment Centers.

For more information related to implementing NCCER at your local campus, please visit http://www.nccer.org/electrical.

INDUSTRY JOB PROJECTION DATA

Electricians, security and fire alarm systems installers, and signal and track switch repairers require an education level of moderate term on-the-job training, a long term on-the- job training, and a postsecondary career and technical award. There is a 12.92% increase in occupational demand at the regional level and an 11.98% increase at the state level. Median annual income for electricians, security and fire alarm systems installers, and signal and track switch repairers is $34,798.40 at the state level and $37, 987.46 at the regional level. A summary of occupational data from the State Workforce Investment Board Data Center is displayed below:

Table 1: Education Level

Program Occupations	Education Level
Electricians	Long-Term on-the-Job Training
Security and Fire Alarm Systems Installers	Moderate-Term on-the-Job Training
Signal and Track Switch Repairers	Postsecondary Career & Technical Award

Table 2: Occupational Overview

	Region	State	United States
2010 Occupational Jobs	3,219	3,880	577,490
2020 Occupational Jobs	3,635	4,345	647,171
Total Change	416	465	69,681
Total % Change	12.92%	11.98%	12.07%
2010 Median Hourly Earnings	$16.73	$18.26	$21.76
2010 Median Annual Earnings	$34,798.40	$37,987.46	$45,251.62
Annual Openings	41	46	6968

Table 3: Occupational Breakdown

Description	2010 Jobs	2020 Jobs	Annual Openings	2010 Hourly Earnings	2010 Annual Earnings 2,080 Work Hours
Electricians	3,002	3,355	35	$19.38	$40,310.40
Security and Fire Alarm Systems Installers	217	280	6	$14.08	$29,286.40
TOTAL	3,219	3,635	41	$16.73	$34,798.40

Table 4: Occupational Change

Description	Regional Change	Regional % Change	State % Change	National % Change
Electricians	353	11.76%	10.57%	10.65%
Security and Fire Alarm Systems Installers	63	29.03%	30.04%	26.34%

ARTICULATION

Articulation credit from Secondary Career Pathway programs to Postsecondary Electrical Technology is available. Secondary students who have completed the articulated the Secondary Career Pathway Courses listed below may be awarded articulated college credit according to Mississippi Community College Board (MCCB) guidelines (http://www.mccb.edu/pdfs/ct/StatewideArtManual201213.pdf).

Articulated Secondary Course	Articulated Postsecondary Course	Aligned Industry Certification
S Electrician and Industrial Maintenance (CIP 46.0302)	ELT 1192 – 3 Fundamentals of Electricity	NCCER Core
	CTE 1143	NCCER Core; Level 1 Modules 1, 2, 3
	CTE 1153	NCCER Core; Level 1 Modules 1, 2, 3

TECHNICAL SKILLS ASSESSMENT

Colleges should report the following for students who complete the program with a career certificate, technical certificate, or an Associate of Applied Science Degrees for technical skills attainment:

NCCER Core Assessment ($45.00)
NCCER Electrical Level 1 and 2 Credential ($50.00 - $100.00)

OR

NCCER NCCT Electrical Level 1 ($45.00)

*Core and Level 1 may be sent together for one-time payment of $50 for both certifications.

OR

MS-CPAS2

ONLINE AND BLENDED LEARNING OPPORTUNITIES

Course content included lecture and laboratory semester credit hours. Faculty members are encouraged to present lecture related content to students in an online or blended learning environment. Training related to online and blended learning will be available to faculty members through the MS Community College Board.

INSTRUCTIONAL STRATEGIES

The NCCER standards were adopted and provide instructional strategies to faculty member implementing the curriculum.

ASSESSMENT STRATEGIES

The NCCER Standards were adopted and provide assessment strategies to faculty member implementing the curriculum. Additionally, performance tasks were included in course content when appropriate.

CREDIT BY EXAMINATION

The following NCCER modules are aligned to courses listed below. Each module will serve as the state recommended exam to reward credit for prior learning experiences. Colleges have the local autonomy to create a college-level exam when awarding credit.

Course Number and Name	**NCCER Credential and Module**
ELT 1192 – 3 Fundamentals of Electricity	NCCER Core Curriculum Module 00101-09—Basic Safety Module 00102-09—Introduction to Construction Math Module 00103-09—Introduction to Hand Tools Module 00104-09—Introduction to Power Tools Module 00105-09—Introduction to Construction Drawing Module 00106-09—Basic Rigging Module 00107-09—Basic Communication Skills Module 00108-09—Basic Employability Skills Module 00109-09—Introduction to Materials Handling
ELT 1232-3 Fundamentals of Electricity, Construction, and Manufacturing	NCCER Core Curriculum Module 00101-09—Basic Safety Module 00102-09—Introduction to Construction Math Module 00103-09—Introduction to Hand Tools Module 00104-09—Introduction to Power Tools Module 00105-09—Introduction to Construction Drawing Module 00106-09—Basic Rigging Module 00107-09—Basic Communication Skills Module 00108-09—Basic Employability Skills Module 00109-09—Introduction to Materials Handling NCCER Level 1 Module 26101-11--Orientation to the Electrical Trade Module 26102-11--Electrical Safety Module 26103-11--Introduction to Electrical Circuits

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.

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 following 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

Accelerated Pathway Credential

			SCH Breakdown			Clock Hour Breakdown		Certification Information
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Clock Hours	Lecture	Lab	Certification Name
CTE 1143 OR ELT 1192/3	Fundamentals of Electricity, Construction and Manufacturing OR Fundamentals of Electricity	2/3	1/2	2/2	75/90	15/30	60/60	NCCER Core
ELT 1144	AC and DC Circuits for Electrical Technology (ELT 1144)	4	2	4	150	30	120	
	Approved Technical Electives	8						
	TOTAL	**14/15**	**3/4**	**6**	**225/240**	**45/60**	**180**	

Career Certificate Required Courses

			SCH Breakdown			Clock Hour Breakdown		Certification Information
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Clock Hours	Lecture	Lab	Certification Name
CTE 1143 OR ELT 1192/3	Fundamentals of Electricity, Construction and Manufacturing OR Fundamentals of Electricity	2/3	1/2	2/2	75/90	15/30	60	NCCER Core
ELT 1123	Commercial Wiring	3	2	2	90	30	60	NCCER Electrical Level 1 and 2
ELT 1113 OR ELT 1183	Residential Wiring OR Industrial Wiring	3	2	2	90	30	60	
ELT 1144	AC and DC Circuits for Electrical Technology	4	2	4	150	30	120	
ELT 1213	Electrical Power	3	2	2	90	30	60	
ELT 1253	Branch Circuit and Service Entrance Calculations	3	2	2	90	30	60	
ELT 1263	Electrical Drawings and Schematics	3	2	2	90	30	60	
ELT 1413	Motor Control Systems	3	2	2	90	30	60	
	Technical Electives	6						
	TOTAL	**30/31**	**15/16**	**18**	**765/780**	**225/240**	**540**	

Technical Certificate Required Courses

			SCH Breakdown			Clock Hour Breakdown			Certification Information
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Clock Hours	Lecture	Lab	Clinical/ Internship	Certification Name
ELT 2114	Equipment Maintenance, Troubleshooting, and Repair	4	1	6	195	15	180		
ELT 2424	Solid State Motor Control	4	2	4	150	30	120		
ELT 2613	Programming Logic Controllers	3	1	4	135	15	120		
	Technical Electives	4							
	TOTAL	**15**	**4**	**14**	**480**	**60**	**420**		

General Education Core Courses

To receive the Associate of Applied Science Degree, a student must complete all of the required coursework found in the Career Certificate option, Technical Certificate option and a minimum of 15 semester hours of General Education Core. 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 or provided primarily within the last semester. Each community college will specify the actual courses that are required to meet the General Education Core Requirements for the Associate of Applied Science Degree at their college. The Southern Association of Colleges and Schools (SACS) Commission on Colleges Standard 2.7.3 from the Principles of Accreditation: Foundations for Quality Enhancement[1] describes the general education core.

Section 2.7.3 In each undergraduate degree program, the institution requires the successful completion of a general education component at the collegiate level that (1) is substantial component of each undergraduate degree, (2) ensures breadth of knowledge, and (3) is based on a coherent rationale. 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 the following areas: humanities/fine arts, social/behavioral sciences, and natural science/mathematics. The courses do not narrowly focus on those skills, techniques, and procedures specific to a particular occupation or profession.

[1] Southern Association of Colleges and Schools Commission on Colleges. (2012). *The principles of accreditation: Foundations for quality enhancement.* Retrieved from http://www.sacscoc.org/pdf/2012PrinciplesOfAcreditation.pdf

Technical Elective Courses

			SCH Breakdown				Clock Hour Breakdown		
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Clinical/ Externship	Total Clock Hours	Lecture	Lab	Clinical/ Externship
CTE 1113	Fundamentals of Microcomputer Applications	3	3			45	45		
CTE 1143	Fundamentals of Construction and Manufacturing	3	2	2		90	30	60	
CTE 1153	Computational Methods of Career and Technical Education	3	2	2		90	30	60	
CTE 1163	Introduction to Sustainability and Renewable Energy	3	2	2		90	30	60	
EET 1214	Digital Electronics	4	2	4		150	30	120	
EET 1334	Solid State Devices and Circuits	4	2	4		150	30	120	
EET 1613	Computer Fundamentals for Electronics/Electricity	3	2	2		90	30	60	
EET 2423	Fundamentals of Fiber Optics	3	2	2		90	30	60	
ELT 1133	Introduction to the National Electric Code	3	2	2		90	30	60	
ELT 1153	Computational Methods for Electrical Technology	3	2	2		90	30	60	
ELT 1223	Motor Maintenance and Troubleshooting	3	2	2		90	30	60	
ELT 1253	Branch Circuit and Service Entrance Calculations	3	2	2		90	30	60	
ELE 1263	Blueprint Reading/Planning in Residential Installation	3	2	2		90	30	60	
ELT 1273	Switching Circuits for Residential, Commercial, and Industrial Applications	3	2	2		90	30	60	
ELT 1283	Estimating the Cost of a Residential Installation	3	2	2		90	30	60	
ELT 1313	Automated Manufacturing Control for Electricity	3	2	2		90	30	60	
ELT 1324	Calibration and Measurement Principles used in the Electrical Industry	4	3	2		105	45	60	
ELT 1334	Flexible Manufacturing Systems for Electrical Technology	4	2	4		150	30	120	
ELT 1343	Fundamentals of Instrumentation	3	2	2		90	30	60	

ELT 1353	Fundamentals of Robotics for Electrical Technology	3	2	2		90	30	60	
ELT 1363	Industrial Hydraulics for Electrical Technology	3	2	2		90	30	60	
ELT 1373	Industrial Pneumatics for Electrical Technology	3	2	2		90	30	60	
ELT 1383	Industrial Robotics for Electrical Technology	3	2	2		90	30	60	
ELT 1393	Servo Control Systems for Electrical Technology	3	2	2		90	30	60	
ELT 1434	Solid State Devices and Circuits for Electrical Technology	4	2	4		150	30	120	
ELT 1513	Data Acquisition and Communications	3	2	2		90	30	60	
ELT 1523	Fundamentals of Fiber Optics for Electrical Technology	3	2	2		90	30	60	
ELT 1533	Fundamentals of Data Communications for Electrical Technology	3	2	2		90	30	60	
ELT 1544	Network Systems for Electrical Technology	4	2	4		150	30	120	
ELT 1553	Satellite Systems	3	1	4		135	15	120	
ELT 1563	Low Voltage and Special Systems for Electrical Technology	3	2	2		90	30	60	
ELT 1614	Principles of Hydraulics and Pneumatics	4	1	6		195	15	180	
ELT 2213	Introduction to Sustainable and Renewable Energy	3	2	2		90	30	60	
ELT 2613	Programmable Logic Controllers	3	2	2		90	30	60	
ELT 2623	Advanced Programmable Logic Controllers	3	2	2		90	30	60	
IMM 1933	Manufacturing Skills	3	2	2		90	30	60	
ELT 291(1–3)	Special Project I	1-3		2-6		60-180		60-180	
ELT 293(1–3)	Special Project II	1-3		2-6		60-180		60-180	
ELT 292(1–6)	Supervised Work Experience I	1-6			3-18	135-810			135-810
ELT 294(1–6)	Supervised Work Experience II	1-6			3-18	135-810			135-810

WBL 191(1-3) WBL 192(1-3) WBL 193(1-3) WBL 291(1-3) WBL 292(1-3) WBL 293(1-3)	Work-Based Learning	1-6			3-18	135-810			135-810

CAREER CERTIFICATE REQUIRED COURSES

Course Number and Name: **ELT 1232-3 Fundamentals of Electricity, Construction, and Manufacturing**

Classification: Career Certificate Core Requirement

Description: This course is designed to introduce students to the fundamental skills associated with all electrical courses. Safety, basic tools, special tools, equipment, and an introduction to simple AC and DC circuits will be included.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
2	1	2	75
3	2	2	90

National Assessment: **NCCER Core Curriculum**

Prerequisite: Instructor Approved

Student Learning Outcomes:

NCCER Core

Module 00101-09--Basic Safety

1. Explain the idea of a safety culture and its importance in the construction crafts.
2. Identify causes of accidents and the impact of accident costs.
3. Explain the role of OSHA in job-site safety.
4. Explain OSHA's General Duty Clause and 1926 CFR Subpart C.
5. Recognize hazard recognition and risk assessment techniques.
6. Explain fall protection, ladder, stair, and scaffold procedures and requirements.
7. Identify struck-by hazards and demonstrate safe working procedures and requirements.
8. Identify caught-in-between hazards and demonstrate safe working procedures and requirements.
9. Define safe work procedures to use around electrical hazards.
10. Demonstrate the use and care of appropriate personal protective equipment (PPE).
11. Explain the importance of hazard communications (HazCom) and material safety data sheets (MSDSs).
12. Identify other construction hazards on your job site, including hazardous material exposures, environmental elements, welding and cutting hazards, confined spaces, and fires.

Module 00102-09--Introduction to Construction Math

1. Add, subtract, multiply, and divide whole numbers, with and without a calculator.
2. Use a standard ruler, a metric ruler, and a measuring tape to measure.
3. Add, subtract, multiply, and divide fractions.
4. Add, subtract, multiply, and divide decimals, with and without a calculator.
5. Convert decimals to percentages and percentages to decimals.
6. Convert fractions to decimals and decimals to fractions.
7. Explain what the metric system is and how it is important in the construction trade.
8. Recognize and use metric units of length, weight, volume, and temperature.
9. Recognize some of the basic shapes used in the construction industry and apply basic geometry to measure them.

Module 00103-09--Introduction to Hand Tools

1. Recognize and identify some of the basic hand tools and their proper uses in the construction trade.
2. Visually inspect hand tools to determine if they are safe to use.
3. Safely use hand tools.

Module 00104-09--Introduction to Power Tools

1. Identify power tools commonly used in the construction trades.
2. Use power tools safely.
3. Explain how to maintain power tools properly.

Module 00105-09--Introduction to Construction Drawings

1. Recognize and identify basic construction drawing terms, components, and symbols.
2. Relate information on construction drawings to actual locations on the print.
3. Recognize different classifications of construction drawings.
4. Interpret and use drawing dimensions.

Module 00106-09--Basic Rigging

1. Identify and describe the use of slings and common rigging hardware.
2. Describe basic inspection techniques and rejection criteria used for slings and hardware.
3. Describe basic hitch configurations and their proper connections.
4. Describe basic load-handling safety practices.
5. Demonstrate proper use of American National Standards Institute (ANSI) hand signals.

Module 00107-09--Basic Communication Skills

1. Interpret information and instructions presented in both verbal and written form.
2. Communicate effectively in on-the-job situations using verbal and written skills.
3. Communicate effectively on the job using electronic communication devices.

Module 00108-09--Basic Employability Skills

1. Explain your role as an employee in the construction industry.
2. Demonstrate critical thinking skills and the ability to solve problems using those skills.
3. Demonstrate knowledge of computer systems and explain common uses for computers in the construction industry.
4. Define effective relationship skills.
5. Recognize workplace issues such as sexual harassment, stress, and substance abuse.

Module 00109-09--Introduction to Materials Handling

1. Define a load.
2. Establish a pre-task plan prior to moving a load.
3. Use proper materials-handling techniques.
4. Choose appropriate materials-handling equipment for the task.
5. Recognize hazards and follow safety procedures required for materials handling.

Level 1 NCCER Electrical Technology

Module 26101-11--Orientation to the Electrical Trade

1. Describe the apprenticeship/training process for electricians.
2. Describe various career paths/opportunities one might follow in the electrical trade.
3. Define the various sectors of the electrical industry.
4. State the tasks typically performed by an electrician.
5. Explain the responsibilities and aptitudes of an electrician.

Module 26102-11--Electrical Safety

1. Recognize safe working practices in the construction environment.
2. Explain the purpose of OSHA and how it promotes safety on the job.
3. Identify electrical hazards and how to avoid or minimize them in the workplace.
4. Explain electrical safety issues concerning lockout/tagout procedures, confined space entry, respiratory protection, and fall protection systems.
5. Develop a task plan and a hazard assessment for a given task and select the appropriate PPE and work methods to safely perform the task.

Module 26103-11--Introduction to Electrical Circuits

1. Define voltage and identify the ways in which it can be produced.
2. Explain the difference between conductors and insulators.
3. Define the units of measurement that are used to measure the properties of electricity.
4. Identify the meters used to measure voltage, current, and resistance.
5. Explain the basic characteristics of series and parallel circuits.

Additional Outcomes

1. Introduce the NEC relative to a specific job.
2. 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.

Course Number and Name: **ELT 1192-3 Fundamentals of Electricity**

Classification: Career Certificate Core Requirement

Description: This course is designed to introduce fundamental skills associated with all electrical courses. Safety, basic tools, special tools, equipment, and an introduction to simple AC and DC circuits will be included.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
2	1	2	75
3	2	2	90

National Assessment: **Selected Modules of NCCER Electrical Level 1**

Prerequisite: Instructor Approved

Student Learning Outcomes:

Level 1 NCCER Electrical Technology

Module 26101-11--Orientation to the Electrical Trade

1. Describe the apprenticeship/training process for electricians.
2. Describe various career paths/opportunities one might follow in the electrical trade.
3. Define the various sectors of the electrical industry.
4. State the tasks typically performed by an electrician.
5. Explain the responsibilities and aptitudes of an electrician.

Module 26102-11--Electrical Safety

1. Recognize safe working practices in the construction environment.
2. Explain the purpose of OSHA and how it promotes safety on the job.
3. Identify electrical hazards and how to avoid or minimize them in the workplace.
4. Explain electrical safety issues concerning lockout/tagout procedures, confined space entry, respiratory protection, and fall protection systems.
5. Develop a task plan and a hazard assessment for a given task and select the appropriate PPE and work methods to safely perform the task.

Module 26103-11--Introduction to Electrical Circuits

1. Define voltage and identify the ways in which it can be produced.
2. Explain the difference between conductors and insulators.
3. Define the units of measurement that are used to measure the properties of electricity.
4. Identify the meters used to measure voltage, current, and resistance.
5. Explain the basic characteristics of series and parallel circuits.

Additional Outcomes

1. Apply general safety procedures in the shop, lab, and industrial environment.
2. Demonstrate the use of electrical tools, equipment, and references.
3. Introduce the National Electrical Code ® relative to a specific job.
4. 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.

Course Number and Name: **ELT 1113 Residential Wiring**

Classification: Career Certificate Core Requirement or Technical Elective

Description: This course includes the advanced skills related to the wiring of single and multifamily buildings. Includes instruction and practice in service-entrance installation, National Electrical Code ® requirements, and specialized circuits.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: **Selected Modules of NCCER Electrical Level 1**

Prerequisite: Instructor Approved

Student Learning Outcomes:

Level 1 NCCER Electrical Technology

Module 26111-11--Residential Electrical Services

1. Explain the role of the National Electrical Code ® in residential wiring and describe how to determine electric service requirements for dwellings.
2. Explain the grounding requirements of a residential electric service.
3. Calculate and select service-entrance equipment.
4. Select the proper wiring methods for various types of residences.
5. Compute branch circuit loads and explain their installation requirements.
6. Explain the types and purposes of equipment grounding conductors.
7. Explain the purpose of ground fault circuit interrupters and tell where they must be installed.
8. Size outlet boxes and select the proper type for different wiring methods.
9. Describe rules for installing electric space heating and HVAC equipment.
10. Describe the installation rules for electrical systems around swimming pools, spas, and hot tubs.
11. Explain how wiring devices are selected and installed.
12. Describe the installation and control of lighting fixtures.

Additional Outcomes

1. Calculate service, feeder, and branch circuit loads for single and multifamily dwellings.
2. Develop a cost estimate to include supply and labor costs.
3. Interpret residential drawings and specifications to determine tools, equipment, and supplies needed for the job.
4. Demonstrate wiring a residence according to the current National Electrical Code ® and local codes.
    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 National Electrical Code ® and local codes.
    b. Draw a sketch, and install specialized circuits to include telephone, low voltage, and remote control systems.

5. Discuss current protective devices, load centers, panel boards, and safety switches.
    a. List five types of over current protective devices and their characteristics.
    b. List installations that require AFCI/GFCI circuits.
    c. Identify types of safety enclosures and configurations.
    d. Draw and label parts of a breaker load center.
6. Demonstrate safety rules for working near or at load centers, panel boards, and safety switches by use of lockout/tagout procedures.

Course Number and Name: **ELT 1123 Commercial Wiring**

Classification: Career Certificate Core Requirement

Description: This course provides instruction and practice in the installation of commercial electrical services including the types of conduit and other raceways, National Electrical Code ® requirements, and three-phase distribution networks.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: **Selected Modules of NCCER Electrical Level 1**

Prerequisite: Instructor Approved

Student Learning Outcomes:

Level 1 NCCER Electrical Technology

Module 26106-11--Device Boxes

1. Describe the different types of nonmetallic and metallic boxes.
2. Calculate the National Electrical Code ® fill requirements for boxes under 100 cubic inches.
3. Identify the appropriate box type and size for a given application.
4. Select and demonstrate the appropriate method for mounting a given box.

Module 26107-11--Hand Bending

1. Make 90° bends, back-to-back bends, offsets, kicks, and saddle bends using a hand bender.
2. Cut, ream, and thread conduit.

Module 26108-11--Raceways and Fittings

1. Identify and select various types and sizes of raceways and fittings for a given application.
2. Identify various methods used to fabricate (join) and install raceway systems.
3. Identify uses permitted for selected raceways.
4. Demonstrate how to install a flexible raceway system.
5. Terminate a selected raceway system.
6. Identify the appropriate conduit body for a given application.

Module 26109-11--Conductors and Cables

1. From the cable markings, describe the insulation and jacket material, conductor size and type, number of conductors, temperature rating, voltage rating, and permitted uses.
2. Determine the allowable ampacity of a conductor for a given application.
3. Identify the National Electrical Code ® requirements for color coding of conductors.
4. Install conductors in a raceway system.

Additional Outcomes

1. Apply general safety rules and current National Electrical Code ® 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 commercial locations.

2. 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 National Electrical Code ® 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.

3. 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.

Course Number and Name: **ELT 1183 Industrial Wiring**

Classification: Career Certificate Core Requirement or Technical Elective

Description: This course includes instruction and practice in the installation of industrial electrical services including the types of conduit and other raceways, National Electrical Code ® requirements, and three-phase distribution networks.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: **Selected Modules of NCCER Electrical Level 1**

Prerequisite: Instructor Approved

Student Learning Outcomes:

Level 2 NCCER Electrical Technology

Module 26204-11--Conduit Bending

1. Describe the process of conduit bending using power tools.
2. Identify all parts of electric and hydraulic benders.
3. Bend offsets, kicks, saddles, segmented, and parallel bends.
4. Explain the requirements of the National Electrical Code ® for bending conduit.
5. Compute the radius, degrees in bend, developed length, and gain for conduit up to six inches.

Module 26205-11--Pull and Junction Boxes

1. Describe the different types of nonmetallic and metallic pull and junction boxes.
2. Properly select, install, and support pull and junction boxes and their associated fittings.
3. Describe the National Electrical Code® regulations governing pull and junction boxes.
4. Size pull and junction boxes for various applications.
5. Understand the NEMA and IP classifications for pull and junction boxes.
6. Describe the purpose of conduit bodies and Type FS boxes.

Module 26206-11--Conductor Installations

1. Explain the importance of communication during a cable-pulling operation.
2. Plan and set up for a cable pull.
3. Set up reel stands and spindles for a wire-pulling installation.
4. Explain how mandrels, swabs, and brushes are used to prepare conduit for conductors.
5. Properly install a pull line for a cable-pulling operation.
6. Explain how and when to support conductors in vertical conduit runs.
7. Describe the installation of cables in cable trays.
8. Calculate the probable stress or tension in cable pulls.

Module 26207-11--Cable Tray

1. Describe the components that make up a cable tray assembly.
2. Explain the methods used to hang and secure cable tray.
3. Describe how cable enters and exits cable tray.
4. Select the proper cable tray fitting for the situation.
5. Explain the National Electrical Code® requirements for cable tray installations.
6. Select the required fittings to ensure equipment grounding continuity in cable tray systems.
7. Interpret electrical working drawings showing cable tray fittings.
8. Size cable tray for the number and type of conductors contained in the system.

Module 26208-11--Conductor Terminations and Splices

1. Describe how to make a good conductor termination.
2. Prepare cable ends for terminations and splices and connect using lugs or connectors.
3. Train cable at termination points.
4. Understand the National Electrical Code® requirements for making cable terminations and splices.
5. Demonstrate crimping techniques.
6. Select the proper lug or connector for the job.

Module 26209-11--Grounding and Bonding

1. Explain the purpose of grounding and bonding and the scope of National Electrical Code ® Article 250.
2. Distinguish between a short circuit and a ground fault.
3. Define the National Electrical Code® requirements related to bonding and grounding.
4. Distinguish between grounded systems and equipment grounding.
5. Use National Electrical Code ® Table 250.66 to size the grounding electrode conductor for various AC systems.
6. Explain the function of the grounding electrode system and determine the grounding electrodes to be used.
7. Define electrodes and explain the resistance requirements for electrodes using NEC Section 250.56.
8. Use National Electrical Code ® Table 250.122 to size the equipment grounding conductor for raceways and equipment.
9. Explain the function of the main and system bonding jumpers in the grounding system and size the main and system bonding jumpers for various applications.
10. Size the main bonding jumper for a service utilizing multiple service disconnecting means.
11. Explain the importance of bonding equipment in clearing ground faults in a system.
12. Explain the purposes of the grounded conductor (neutral) in the operation of overcurrent devices.

Module 26210-11--Circuit Breakers and Fuses

1. Explain the necessity of overcurrent protection devices in electrical circuits.
2. Define the terms associated with fuses and circuit breakers.
3. Describe the operation of a circuit breaker.
4. Apply the National Electrical Code® requirements for overcurrent devices.
5. Describe the operation of single-element and time delay fuses.

Course Number and Name: **ELT 1144 AC and DC Circuits for Electrical Technology**

Classification: Career Certificate Core Requirement

**Note: EET 1114 DC Circuits and EET 1124 AC Circuits can be taken in lieu of ELT 1144*

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.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	150

National Assessment: **Selected Modules of NCCER Electrical Level 1 and 2**

Prerequisite: Instructor Approved

Student Learning Outcomes:

Level 1 NCCER Electrical Technology

Module 26104-11--Electrical Theory

1. Explain the basic characteristics of combination circuits.
2. Calculate, using Kirchhoff's voltage law, the voltage drop in series, parallel, and series-parallel circuits.
3. Calculate, using Kirchhoff's current law, the total current in parallel and series-parallel circuits.
4. Using Ohm's law, find the unknown parameters in series, parallel, and series-parallel circuits.

Module 26112-11--Electrical Test Equipment

1. Explain the operations of and describe the following pieces of test equipment: (Voltmeter, Ohmmeter, Clamp-on Ammeter, Multimeter, Megohmmeter, Motor and Phase Rotation Testers)
2. Select the appropriate meter for a given work environment based on category ratings.
3. Identify the safety hazards associated with the various types of test equipment.

Level 2 NCCER Electrical Technology

Module 26103-11--Introduction to Electrical Circuits

1. Define voltage and identify the ways in which it can be produced.
2. Explain the difference between conductors and insulators.
3. Define the units of measurement that are used to measure the properties of electricity.
4. Identify the meters used to measure voltage, current, and resistance.
5. Explain the basic characteristics of series and parallel circuits.

Module 26201-11-- Alternating Current

1. Calculate the peak and effective voltage or current values for an AC waveform.
2. Calculate the phase relationship between two AC waveforms.
3. Describe the voltage and current phase relationship in a resistive AC circuit.
4. Describe the voltage and current transients that occur in an inductive circuit.
5. Define inductive reactance and state how it is affected by frequency.
6. Describe the voltage and current transients that occur in a capacitive circuit.
7. Define capacitive reactance and state how it is affected by frequency.
8. Explain the relationship between voltage and current in the following types of AC circuits: (RL circuit, RC circuit, LC circuit, RLC circuit)

9. Explain the following terms as they relate to AC circuits: (True power, Apparent power, Reactive power, Power factor).
10. Explain basic transformer action.

Additional Outcomes

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. 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.

Course Number and Name: **ELT 1253 Branch Circuit and Service Entrance Calculations**

Classification: Career Certificate Core Requirement

Description: The course is designed to teach students the calculations of circuit sizes for all branch circuits and service entrances in all electrical installation. Proper use of the National Electrical Code ® will be required.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: **Selected Modules of NCCER Electrical Level 1**

Prerequisite: Instructor Approved

Student Learning Outcomes:

Level 1 NCCER Electrical Technology

Module 26105-11-- Introduction to the National Electrical Code®

1. Explain the purpose and history of the National Electrical Code ®.
2. Describe the layout of the National Electrical Code ®.
3. Demonstrate how to navigate the National Electrical Code ®.
4. Describe the purpose of the National Electrical Manufacturers Association and the NFPA.
5. Explain the role of nationally recognized testing laboratories.

Additional Outcomes

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 National Electrical Code ® 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 National Electrical Code ®.
    c. Calculate the branch circuit size for appliances according to National Electrical Code ®.
    d. Calculate the branch circuit size for heat according to National Electrical Code ®.

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 National Electrical Code ® 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 National Electrical Code ®.
    a. Calculate the wattage of the small appliance and laundry circuits as specified in National Electrical Code ®
    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.

Course Number and Name: **ELT 1263 Electrical Drawings and Schematics**

Classification: Career Certificate Core Requirement

Description: This course introduces architectural, industrial, mechanical, and electrical symbols needed to read blueprints, schematic diagrams. Prints and drawings associated with electrical wiring will be studied.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: **Selected Modules of NCCER Electrical Level 1**

Prerequisite: Instructor Approved

Student Learning Outcomes:

Level 1 NCCER Electrical Technology

Module 26110-11--Basic Electrical Construction Drawings

1. Explain the basic layout of a set of construction drawings.
2. Describe the information included in the title block of a construction drawing.
3. Identify the types of lines used on construction drawings.
4. Using an architect's scale, state the actual dimensions of a given drawing component.
5. Interpret electrical drawings, including site plans, floor plans, and detail drawings.
6. Interpret equipment schedules found on electrical drawings.
7. Describe the type of information included in electrical specifications.

Additional Outcomes

1. 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.

2. 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.

3. 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.

4. Prepare blueprints to meet National Electrical Code ® 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 appliances, multi-wire, individual, and general-purpose branch circuits.

5. Describe, identify and construct schematic diagrams using basic schematic symbols.
    a. Describe, identify and draw IEC and NEMA components.

6. Demonstrate the ability to read and interpret electrical schematics.
    a. Identify line and sheet numbers.
    b. Demonstrate knowledge of different sheet cross-reference methods
    c. Demonstrate the ability to navigate across multiple pages using cross-references

7. Identify read and understand IEC, NEMA and ISO schematics

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

Classification: Career Certificate Core Requirement

Description: This course includes the 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.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: **Selected Modules of NCCER Electrical Level 1**

Prerequisite: Instructor Approved

Student Learning Outcomes:

Level 2 NCCER Electrical Technology

Module 26211-11--Control Systems and Fundamental Concepts

1. Describe the operating principles of contactors and relays.
2. Select contactors and relays for use in specific electrical systems.
3. Explain how mechanical contactors operate.
4. Explain how solid-state contactors operate.
5. Install contactors and relays according to the National Electrical Code ® requirements.
6. Select and install contactors and relays for lighting control.
7. Read wiring diagrams involving contactors and relays.
8. Describe how overload relays operate.
9. Connect a simple control circuit.
10. Test control circuits.

Additional Outcomes

1. Install different control circuits and devices.
    a. Diagram and wire a two-wire and three-wire motor control circuit with indicating pilot lights.
    b. Diagram, wire, and troubleshoot an on-delay and off-delay timer circuit.
    c. Diagram and wire multi-control manual station.
    d. Diagram and wire a "hands-off-automatic" control station.
    e. Diagram and wire a jog-forward/jog-reverse control.

2. Troubleshoot different control circuits and devices.
    a. Troubleshoot a two-wire and three-wire motor control circuit with indicating pilot lights.
    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.

TECHNICAL CERTIFICATE CORE COURSES

Course Number and Name: **ELT 2114 Equipment Maintenance, Troubleshooting, and Repair**

Classification: Technical Certificate Core Requirement

Description: This course includes maintenance and troubleshooting techniques, use of technical manuals and test equipment, and inspection/evaluation/repair of equipment.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	1	6	195

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Discuss and apply proper safety procedures regarding maintenance, troubleshooting, and repair of equipment.

2. Perform preventive maintenance on equipment.
    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.
    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.
    a. Prepare a bill of materials list for a specific job.
    b. Calculate the labor factor for a specific job.

Course Number and Name: **ELT 2424 Solid State Motor Control**

Classification: Technical Certificate Core Requirement

Description: This course provides knowledge of the principles and operation of solid state motor control, and variable frequency drives. The design, installation, and maintenance of different solid state devices for motor control will be introduced.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	150

National Assessment: **Selected Modules of NCCER Electrical Level 2**

Prerequisite: Instructor Approved

Student Learning Outcomes:

NCCER Electrical Level 2

Module 26202-11--Motors: Theory and Application

1. Define the following terms: (Controller, Duty cycle, Full-load amps, Interrupting rating, Thermal protection, NEMA design letter, Overcurrent, Overload,
   Power factor, Rated full-load speed, Rated horsepower, Service factor)
2. Describe the various types of motor enclosures.
3. Explain the relationships among speed, frequency, and the number of poles in a three-phase induction motor.
4. Define percent slip and speed regulation.
5. Explain how the direction of a three-phase motor is changed.
6. Describe the component parts and operating characteristics of a three-phase wound-rotor induction motor.
7. Describe the component parts and operating characteristics of a three-phase synchronous motor.
8. Describe the design and operating characteristics of various DC motors.
9. Describe the methods for determining various motor connections.
10. Describe general motor protection requirements as delineated in the National Electrical Code® (NEC®).
11. Define the braking requirements for AC and DC motors.

Additional Learning Outcomes

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.

Course Number and Name: **ELT 2613 Programmable Logic Controllers**

Classification: Technical Certificate Core Requirement

Description: This course provides instruction in the use of programmable logic controllers (PLCs) in modern industrial settings. The operating principles, installation and basic programming of PLCs will be covered.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	1	4	135

National Assessment: **Selected Modules of NCCER Electrical Level 1**

Prerequisite: Instructor Approved

Student Learning Outcomes:

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.

TECHNICAL ELECTIVE COURSES

Course Number and Name: **ELT 1133 Applications of the National Electrical Code**

Classification: Technical Elective

Description: The course is designed to place emphasis on developing the student's ability to locate, interpret and properly apply information in the National Electrical Code in real-world applications.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Use the National Electrical Code ® as a reference manual to locate information and give a reference of where the information can be found.
    a. Find and interpret the requirements for installing various electrical equipment and conductors in dry, damp, and wet locations.
    b. Calculate the size of the current carry conductors needed to supply a circuit.
    c. Calculate the current carrying capabilities of conductors with variances in the number of conductors in a raceway and changes in ambient temperature.
    d. Calculate the size of service conductors for the ungrounded, grounded, and grounding conductor.
    e. Calculate the number of specific current carry conductors that can be installed in a raceway.

Course Number and Name: **ELT 1153 Computational Methods for Electrical Technology**

Classification: Technical Elective

Description: Study of computational skills required for the development of accurate design and drafting methods used in the electrical technology profession.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

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

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

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

4. 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.

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

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

Course Number and Name: **ELT 1163 Drafting for Electrical Technology**

Classification: Technical Elective

Description: This course provides a study of the computational skills required for the development of accurate design and drafting methods used in the electrical technology profession.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

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.

Course Number and Name: **ELT 1213 Electrical Power**

Classification: Technical Elective

Description: This course provides information on electrical motors and their installation. Instruction and practice in using the different types of electrical motors, transformers, and alternators.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Discuss safety and environmental protection concerns associated with electrical power equipment.
    a. List safety precautions associated with motors and transformers.
    b. Explain the procedures for working with and disposing of hazardous materials.

2. Wire single-phase electrical components.
    a. Sketch and connect a single-phase transformer for high- and low-voltage applications.
    b. Identify, sketch, and wire different types of single-phase motors.
    c. Explain and demonstrate the applications of an AC generator.

3. Wire three-phase electrical components.
    a. Sketch and connect a three-phase AC transformer to include delta and wye and three- wire and four-wire systems.
    b. Identify, draw, and wire different types of three-phase motors to include low and high voltage requirements.

NCCER Electrical Level 1

Module 26104-11--Electrical Theory

1. Explain the basic characteristics of combination circuits.
2. Calculate, using Kirchhoff's voltage law, the voltage drop in series, parallel, and series-parallel circuits.
3. Calculate, using Kirchhoff's current law, the total current in parallel and series-parallel circuits.
4. Using Ohm's law, find the unknown parameters in series, parallel, and series-parallel circuits.

Course Number and Name: **ELT 1223 Motor Maintenance and Troubleshooting**

Classification: Technical Elective

Description: This course includes the principles and practice of electrical motor repair. Topics on the disassembly/assembly and preventive maintenance of common electrical motors are discussed.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Apply general safety and safety requirements for working with electric motors.
    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.
    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.
    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.

Course Number and Name: **ELT 1273 Switching Circuits for Residential, Commercial, and Industrial Applications**

Classification: Technical Elective

Description: This course provides an introduction to various methods by which switches and control devices are installed. It includes installation and operation of residential/commercial automation systems.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

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.

Course Number and Name: **ELT 1283 Cost Estimation for Electrical Installation**

Classification: Technical Elective

Description: This course gives students the knowledge and ability to estimate the cost of an electrical installation using specifications for various structures.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

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.
    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.
    a. Determine rooms that 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.

Course Number and Name: **ELT 2123 Automated Manufacturing Controls for Electrical Technology**

Classification: 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.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Demonstrate the ability to develop a robotics process utilized in the electrical industry.
    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.
    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.

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

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

Classification: 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.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	3	2	105

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

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.

3. Describe and demonstrate Statistical Process Control (SPC).
    a. Perform basic operations of statistics.
    b. Explain statistics and the relationship to process control instrumentation.

Course Number and Name: **ELT 2133 Flexible Manufacturing Systems for Electrical Technology**

Classification: 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.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

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.

Course Number and Name: **ELT 1243 Fundamentals of Instrumentation**

Classification: 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.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Demonstrate a working knowledge of instrumentation as it pertains to the electrical industry.
    a. Define terms associated with instrumentation.
    b. Discuss basic theory of hydraulics, pneumatics, and electromagnetic controls.
    c. Identify basic symbols used with hydraulics, pneumatics, and electromagnetic systems.

2. Identify the type of instrumentation input and output devices, and describe their applications.
    a. Describe control elements for pressure, flow, temperature, and level.
    b. Identify the types of input and output devices.
    c. Describe the input and output devices.

3. Identify the types of electrical signals used in instrumentation.
    a. Describe the transmission of information to include current, pressure, and frequency.
    b. Explain the principles of the transmission information input and output.

4. Describe fundamentals of electrical and electronic process controls.
    a. Label a block diagram of an open loop system and a closed loop system.
    b. Describe characteristics of an open loop and a closed loop system.

5. Design a preventive maintenance program for instrumentation systems.
    a. Describe the techniques and procedures for troubleshooting, calibrating, and repairing an instrumentation system.
    b. Demonstrate the ability to sketch a piping and instrument drawing.

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Course Number and Name: **ELT 1353 Fundamentals of Robotics for Electrical Technology**

Classification: 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.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Describe the various major components of all robots.
    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.
    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.
    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.

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

Classification: 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.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

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.
    a. Wire an electrical control circuit.
    b. Interface a hydraulic circuit with ladder logic.
    c. Interface a hydraulic circuit with PLCs.

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

Classification: 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.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Define and describe basic laws governing gases.
    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.
    a. Explain the logic for drawing symbols for pneumatic components.
    b. Draw individual pneumatic components.

3. Describe the operation and nomenclature of various compressors.
    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.
    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.
    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.
    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.

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.
    a. Explain the construction and use of solenoids in directional controls.
    b. Construct a pneumatic circuit that is controlled electrically.

Course Number and Name: **ELT 2153 Industrial Robotics for Electrical Technology**

Classification: 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.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Demonstrate the ability to integrate a robot into a process affiliated with the electrical industry.
    a. Write programs on industrial robots to perform simulated industrial processes to operate within the confines of each robot's work envelope.
    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.

2. Demonstrate the ability to integrate peripheral equipment.
    a. Program and interface peripheral devices such as a programmable logic controller into robotics work cells.
    b. Interface contact and noncontact sensors into robotics work cell.

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.).

Course Number and Name: **ELT 2163 Servo Control Systems for Electrical Technology**

Classification: 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.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

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.

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

Classification: Technical Elective

Description: This course provides instruction on electronic devices that include PN junction diodes, bipolar transistors, bipolar transistor circuits, and unipolar devices with emphasis on low-frequency application and troubleshooting.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	150

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

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.
    d. Analyze a forward biased PN junction.
    e. Analyze a reverse biased 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 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 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 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.

Course Number and Name: **ELT 1513 Data Acquisition and Communications**

Classification: Technical Elective

Description: This is a course in acquisition and communication of systems data in industrial automated applications.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

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. Explain 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.

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

Classification: Technical Elective

Description: This course provides knowledge of Fiber-optic cables in modern industry applications. It includes installation, operation and repair of fiber optic cables.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

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. Describe the history and advantages of fiber-optic systems and how they relate to the electrical industry.
    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.
    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.
    a. Describe the construction of optical fibers.
    b. Explain optical fiber cable specifications.

5. Describe properties of different types of optical fibers.
    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.
    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
    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.

Course Number and Name: **ELT 1533 Fundamentals of Data Communications**

Classification: Technical Elective

Description: This course includes concepts of telephony, local area networks, wide area networks, data transmission, and topology methods. It covers installation and design of wired and wireless networks.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

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.
    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.
    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, CAN, 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.

Course Number and Name: **ELT 1563 Low Voltage and Special Systems for Electrical Technology**

Classification: Technical Elective

Description: This course provides information and hands-on experience in installation, operation, troubleshooting, and repair of residential- and commercial-use low voltage and communication systems, including analog and digital key systems.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

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. Explain and analyze the aspects of basic telephone service.
    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.
    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.
    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.

Course Number and Name: **ELT 1614 Principles of Hydraulics and Pneumatics**

Classification: Technical Elective

Description: This course provides instruction in basic principles of hydraulics and pneumatics and the inspection, maintenance, and repair of hydraulic and pneumatic systems

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	1	6	195

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Describe and discuss basic principles of hydraulics as related to industrial maintenance.
    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.
    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.
    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.
    a. Perform scheduled preventive maintenance on an air compressor.
    b. Evaluate pneumatic equipment and devices for leakage and proper operation.

Course Number and Name: **ELT 2623 Advanced Programmable Logic Controllers**

Classification: Technical Elective

Description: This is an advanced PLC course that provides instruction in the various operations and installations of advanced electrical control systems. Information in areas such as sequencer, program control, introduction to function blocks, sequential function chart, introduction to HMI, and logical and conversion instructions will be included.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

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.

Course Number and Name: **ELT 291(1-3), ELT 293(1-3) Special Project I, II**

Classification: Technical Elective

Description: This course provides 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.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
1		2	60
2		4	120
3		6	180

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Develop a written plan and blueprints that detail the activities and projects to be completed.
    a. Utilize a written plan that details the activities and projects to be completed.
    b. Perform written occupational objectives in the special project.

2. Assess accomplishment of objectives.
    a. Prepare daily written assessment of accomplishment of objectives.
    b. Present weekly written reports to the instructor in activities performed and objectives accomplished.

3. Utilize a set of written guidelines for the special project.
    a. Develop and follow a set of written guidelines for the special project.

Course Number and Name: **ELT 292 (1-6), ELT 294(1-6)** **Supervised Work Experience I, II**

Classification: Technical Elective

Description: This course is 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 per 45 industrial contact hours.

Hour Breakdown:

Scheduled Hours	Lecture	Externship	Clock Hours
1		3	135
2		6	270
3		9	405
4		12	540
5		15	675
6		18	810

National Assessment: None

Prerequisite: Instructor Approved

Student Learning Outcomes:

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.

RECOMMENDED TOOLS AND EQUIPMENT

Capitalized Items

Access to some tools and equipment may be provided by Machine Shop, Electrical, Plumbing/Pipefitting, Automotive, and Welding Program facilities.

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)
43. Mechanical Systems Trainer (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 student)
3. Analog VOM (1 per student)
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)
21. Capacitance meter (1)
22. CAD Weld System

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

CURRICULUM DEFINITIONS AND TERMS

- Course Name – A common name that will be used by all community 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 Certificate Required Course – A required course for all students completing a career certificate.
    - Technical Certificate Required Course – A required course for all students completing a technical certificate.
    - Technical Elective – Elective courses that are available for colleges to offer to students.

- Description – A short narrative that includes the major purpose(s) of the course

- 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

- Student Learning Outcomes – A listing of the student outcomes (major concepts and performances) 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 college. 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.

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

- Adding new student learning outcomes to complement the existing competencies and suggested objectives in the program framework.
- Revising or extending the student learning outcomes
- 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)