Saskatchewan
Education

Electrical and Electronics 10, 20, A30, B30

Curriculum Guide

A Practical and Applied Art

Saskatchewan Education
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Introduction

Within Core Curriculum, the Practical and Applied Arts (PAA) is a major area of study that incorporates five traditional areas of Business Education, Computer Education, Home Economics, Industrial Arts and Work Experience Education. Saskatchewan Education, its educational partners and other stakeholders have collaborated to complete the PAA curriculum renewal. Some PAA curriculum guidelines have been updated; some components have been integrated, adapted or deleted; some Locally Developed Courses of study have been elevated to provincial status; and some new guidelines have been developed.

A companion *Practical and Applied Arts Handbook* provides background on Core Curriculum philosophy, perspectives and initiatives. The Handbook articulates a renewed set of goals for PAA. It presents additional information about the PAA area of study, including guidelines about work study and related transition-to-work dimensions. In addition, the *Practical and Applied Arts Information Bulletin* provides direction for administrators and others regarding the implementation of PAA courses. Lists of recommended resources for all guidelines will be compiled into a PAA Bibliography with periodic updates. An initial list of resources for Electrical and Electronics accompanies the curriculum guide.

Philosophy and Rationale

In today's rapidly changing world, the use of electricity and electronic devices is ever expanding. A basic understanding of electrical and electronics theory and applications will enhance the ability of students to manage new technologies as they emerge.

Providing for learning electrical and electronics skills at the Secondary Level affords students an opportunity to gain experience and employment in the private sector. There may also be an opportunity for students who have completed courses to apply for advanced standing in a post-secondary training program. Students may be granted time credit should they register as an apprentice following high school completion. Some students may choose these courses of study for personal use.

Courses in Electrical and Electronics are offered to:
- introduce high school students to specific life skills that have practical lifetime application
- give students the opportunity to investigate career options
- develop specific employability skills that will facilitate entry level employment or participation in post-secondary education and training.

Aim, Goals and Foundational Objectives

Aim

The aim of the Electrical and Electronics 10, 20, A30, B30 curriculum is to provide students with opportunities to acquire knowledge and develop skills used in the electrical and electronics industry and to become familiar with career opportunities in this industry in Saskatchewan.

Goals

Applied Technology:
- To develop skills using hand and power tools of the industry
- To develop skills designing circuits, assembling components, soldering, wiring
- To develop skills using testing equipment, schematic drawings, blueprints, technical specifications, along with the testing and trouble shooting of electrical equipment.

Awareness:
- To provide students with experiences and information that delineate possible career and post-secondary training choices in the industry.

Communication:
- To develop the ability to read electrical circuit diagrams, electronics schematics and related technical manuals
- To practise effective communication skills.

Health and Safety:
- To develop an awareness of the responsibility and need for safe procedures that must be followed in the work environment.

Mathematics:
- To provide students with a practical application of mathematical computations used in the electrical and electronics industry.

Personal Development:
- To develop cooperative work skills, professional ethics and behaviour, personal time management and personal wellness skills.

Foundational Objectives

Foundational objectives are the major, general statements that guide what each student is expected to achieve in the modules of this PAA curriculum guide. Foundational objectives indicate the most important knowledge, skills, attitudes/values and abilities for a student to learn in a subject. Both the Foundational Objectives for Electrical and Electronics and the Common Essential Learnings (CELs) Foundational Objectives to be emphasized are stated in this document. Some of these statements may be repeated or enhanced in different modules for emphasis. The Foundational Objectives of the Core Modules of the Electrical and Electronics curriculum include:

- To read and interpret schematic diagrams and other technical documents.
- To use appropriate terminology for electricity or electronics in context.
- To become knowledgeable about the various principles and characteristics of electricity and electronics.
- To analyze circuits and predict their output.
- To be knowledgeable and skilled with different materials and devices and their application in the electricity and electronics field.
- To design and/or build circuits to an acceptable standard capable of producing a desired output.
- To work safely and cooperatively with other students and handle materials in a safe manner.
- To demonstrate the safe use and knowledge of meters and hand and power tools used in the electrical industry.
- To read and interpret meter readings.
- To test and evaluate the integrity of electrical and electronic components.
- To be knowledgeable about career opportunities in electrical and electronics fields.
- To become aware of post-secondary programs in the electrical and electronics fields.
- To increase self-esteem from success with equipment, materials and techniques used.
- The student will develop an awareness of career opportunities in the electrical trades.
- To provide students with experience in the electrical trades that will enable them to make informed career decisions.

Codes for Common Essential Learnings (CELs)

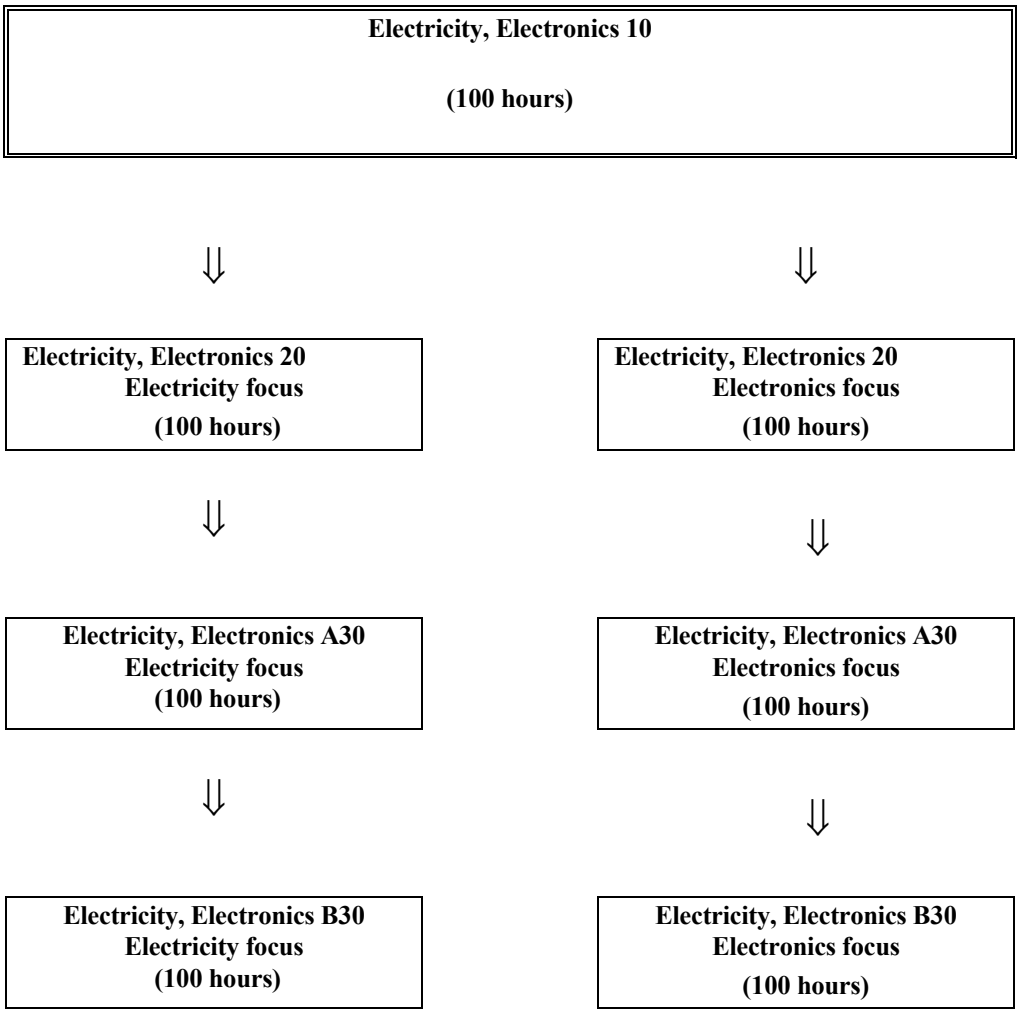
All of the subject and CELs Foundational Objectives are stated explicitly at the beginning of each module.

COM	=	Communication
NUM	=	Numeracy
CCT	=	Critical and Creative Thinking
TL	=	Technological Literacy
PSVS	=	Personal and Social Values and Skills
IL	=	Independent Learning

Course Components and Considerations

Under Core Curriculum policy, each Secondary Level single (1.0) credit is based on 100 hours of instruction. Introductory modules may be completed at the Middle Level to help meet Middle Level requirements.

Modules were designed for a 400-hour Electrical and Electronics program. The course developed for the Introductory level (10) provides access to further studies in electricity, the Electrical focus leading to a career opportunity as an Electrician or the Electronics focus leading to a career as an Electronics Technician.



Program Delivery

These courses may be delivered in a variety of ways involving classroom instruction, computer instruction, laboratory activities and industrial work sites. They lend themselves well to coordination with work study programs and industry partnerships. They provide opportunities for students who are interested in pursuing the electrical or electronics trade as a career path or for self-interest.

Work study is a suggested optimal component of all Practical and Applied Arts (PAA). A work study module is included. The *Practical and Applied Arts Handbook* contains a specific guide to set up optional work study components in one or more of the courses.

Suggestions For Module Configuration

1. Modules that should be taught first at the Introductory Electrical level:

   Module 1A - Safety and Health
   Module 2A - Concepts About Electricity
   Module 4A - Wiring Circuits

2. Modules that could be shared for either the Electrical or the Electronics Course(s):

   Module 1 - Safety and Health
   Module 2 - Concepts About Electricity
   Module 3 - Electrical Principles of Alternating Current Circuits and Transformers
   Module 4 - Wiring Circuits
   Module 6 - Conductors
   Module 7 - Overcurrent Devices
   Module 17 - Introduction to Electronics
   Module 19 - Measuring Instruments (Meters)
   Module 20 - Careers
   Module 22 - Soldering, De-soldering and Recycling Components

Work Study Component

Modules 34A, B, C permit the student to apply academic and school-based learning to workplace settings. Students are provided with an opportunity to experience the optional work study component through appropriate placements. The module Work Study Preparation and Follow-up Activities must be taught if the students have not participated in a work study module prior to enrolling in this course. If students have completed a previous work study module in another course, less time may need to be spent in work study preparation, thus allowing more time for other modules. See the *Practical and Applied Arts Handbook* for detailed information under the "Work Study Guidelines" section. Students who have previously taken a work study module may cover content developed by Saskatchewan Labour found in the *Career and Work Exploration Curriculum Guide* and the *Practical and Applied Arts Handbook* to supplement their learning. These content references include:

- Labour Standards
- Occupational Health and Safety Act
- Workplace Hazardous Materials Information System (WHMIS).

Creating Partnerships for Work Study

Creating partnerships is important to the success of this curriculum. There are three distinct partners that play an important role: industry, the school and the student.

Personal contact is the best approach to building partnerships. One should begin by making a presentation to colleagues within the school, to the student body, to school board members, to parents and to local businesses. It is important to outline the curriculum and the benefits and responsibilities for each of the partners.

See the modules outlined in the curriculum and the "Work Study Guidelines" in the *Practical and Applied Arts Handbook* for further information on work study.

Portfolios

A personal portfolio is a valuable organizer of student projects and assignments. It encourages students to collect examples of their work as they progress through the various activities, labs and projects. Selecting particular items to include in a portfolio encourages students to reflect on what they have learned or accomplished and what they have yet to learn. Portfolio items may include: journal notes, drafts, photographs, audio or video tapes, computer discs, sketches and drawings, etc. Portfolios may be used for peer, teacher, self- assessment and as a format to present selected works to parents, post-secondary institutions or potential employers. In addition, the portfolio can demonstrate the link between home, school and community in the student's education. Each student should have a portfolio representing his or her work during the course.

The portfolio helps students:
- reflect on personal growth and accomplishment
- see links between home, school and community education and activities
- collect materials to prepare applications for post-secondary education and scholarship program entrance
- collect materials to prepare for employment applications
- focus on career planning.

The portfolio helps teachers:
- provide a framework for independent learning strategies for the student
- communicate student learning from one school year to another in a specific area of study
- identify career planning needs for students
- assess and evaluate the student's progress and achievement in a course of study

The portfolio helps post-secondary institutions:
- determine suitable candidates for awards and scholarships
- evaluate candidates for program entrance
- evaluate prior learning for program placement

The portfolio helps the community:
- reflect on the involvement in a student's education and the support offered to learners
- demonstrate the link between the home, school and community in education

The portfolio helps potential employers:
- identify employable skills desired in future employees
- provide evidence of knowledge and skill development of potential employees.

Working Portfolio

Students collect work over time in a working folder. Each student should also keep a journal of observations, critiques, ideas and reflections as part of his or her working portfolio. Items in this portfolio may be used for the purpose of reflection, for ongoing and summative evaluations, peer, teacher and self evalutions, for documenting skill development and mastery.

Working portfolios may be used for purposes of conferencing between student and teacher, teacher and parent, teacher and

teacher, or student and student. When a teacher examines a student's portfolio in order to make a decision regarding student progress, the information it contains may become documented evidence for the evaluation.

A daily journal may also become a part of a working portfolio as a means of tracking the student's use of time and to record progress on ideas that are being developed. This will provide the student with a focus for self-directed or independent learning as well as an anecdotal record for part of the course evaluation.

Presentation Portfolio

To compile a presentation portfolio, students should select items from their working portfolio. The presentation portfolio should cover the range of students' experiences and should display their best efforts. The preparation of a presentation portfolio can be an assessment strategy. It is strongly suggested that students at the 30 level prepare a presentation portfolio suitable for submission to potential employers or post-secondary institutions.

Through collecting, selecting and reflecting, students are able to compile presentation portfolios that display their best collection of work.

Extended Study Modules

The extended study module is designed to provide schools with an opportunity to meet current and future demands that are not addressed by current modules in the renewed PAA curriculum.

The flexibility of this module allows a school/school division to design one new module per credit to complement or extend the study of existing pure core modules and optional modules. The extended study module is designed to extend the content of the pure courses and to offer survey course modules beyond the scope of the selection of PAA modules.

The list of possibilities for topics of study or projects for the extended study module approach is as varied as the imagination of those involved in using the module. These optional extended study module guidelines, found in the *Practical and Applied Arts Handbook*, should be used to strengthen the knowledge, skills and processes advocated in the Practical and Applied Arts curriculum in which the extended study module is used.

It is recommended that a summary of any extended study module be sent to the Regional Superintendent of Curriculum and Instruction to establish a resource bank of module topics.

For more information on the extended study module, refer to the *Practical and Applied Arts Handbook*.

Resources

To support the principle of Resource-based Learning, instructional resources have been evaluated and recommended for the teaching and learning of Electrical and Electronics 10, 20, A30, B30. See the enclosed *Electrical and Electronics 10,20, A30, B30: An Initial List of Implementation Materials* for a list of annotated resources. Teachers should also consult the comprehensive PAA bibliography. The annual L*earning Resource Materials Update* can also provide information about new materials evaluated since the curriculum was printed.
To order materials, except videos, teachers should also consult the department's Learning Resources Distribution Centre (LRDC) catalogue. An on-line ordering service is available at lrdc.sasked.gov.sk.ca.

The on-line version of this Guide is accessible at www.sasked.gov.sk.ca/docs/paa.html. It will be "Evergreened", as appropriate.

Assessment and Evaluation

Student evaluation is an important part of teaching as it allows the teacher to report the successes and challenges of the student and the parent. Evaluation also provides valuable feedback about how a student learns best. It is important that teachers use a variety of evaluation strategies to evaluate student progress. Additional information on evaluation of student achievement can be found in the Saskatchewan Education documents *Student Evaluation: A Teacher Handbook*, 1991 and *Curriculum Evaluation in Saskatchewan*, 1991.

It is important that the teacher discuss the evaluation strategies to be used in the course, when the evaluation can be expected to occur and the weighting of each evaluation strategy and how it relates to the overall student evaluation. The weighting of the evaluation should be determined in relation to the amount of time spent and emphasis placed on each area of the course as suggested in the curriculum guidelines.

The *Electrical and Electronics Curriculum Guide10, 20, A30, B30* provides many opportunities for teachers to use a variety of instructional and evaluation strategies. Evaluation instruments used in the teaching of this course are included the *Practical and Applied Arts Handbook*. Sample copies of overall evaluation for the course, evaluation for general student skills and work study are included for teachers to adapt and use. Industry specific skills are reflected the training plans (Appendix B).

A *sample* evaluation scheme for this course appears below:

Portfolios		10%
Written Tests		10%
Practical Tests	20%	
Project Work		30%
Assignments		20%
Class Presentations or Work Study:	10%	

Electrical Course Modules Overview

Module Code	Module		Suggested time (hours)
★ELEC01A	Module 1A:	Safety and Health (Core)	8-15
★ELEC01B,C,D	Module 1B, C, D:	Safety and Health (Core)	3-5
★ELEC02A	Module 2A:	Concepts About Electricity (Core)	10-20
★ELEC02B,C,D	Module 2B, C, D:	Concepts About Electricity (Core)	3-5
★ELEC03A,B	Module 3A, B:	Electrical Principles of Alternating Current Circuits and Transformers (Core)	5-8
★ELEC04A	Module 4A:	Wiring Circuits (Core)	15-25
★ELEC04B,C	Module 4B, C:	Wiring Circuits (Core)	3-5
★ELEC05A,B,C	Module 5A, B, C:	Relays and Relay Circuits (Core)	3-5
★ELEC06	Module 6:	Conductors (Core)	5-10
★ELEC07A,B	Module 7A, B:	Overcurrent Devices (Core)	10-15
★ELEC08A,B,C	Module 8A, B, C:	Residential Wiring Methods (Core)	10-15
★ELEC09A	Module 9A:	Residential Branch Circuits and Services (Core)	15-20
★ELEC9B	Module 9B:	Residential Circuit Layout (Core)	15-25
ELEC10A	Module 10A:	Direct Current Generators, Basic Shunt (Optional)	5-7
ELEC10B	Module 10B:	Direct Current Generators, Advanced Shunt (Optional)	5-15
ELEC11A,B	Module 11A, B:	Direct Current Motors (Optional)	5-15
★ELEC12A	Module 12A:	Residential Lighting (Core)	15-25
★ELEC12B	Module 12B:	Residential Lighting (Core)	5-10
ELEC13A,B,C	Module 13A, B, C:	Alternating Current: Theory and Circuits (Core)	7-10
★ELEC14A	Module 14A:	Single Phase Power Transformers (Core)	10-20
★ELEC14B	Module 14B:	Single Phase Power Transformers (Core)	5-10
ELEC15A	Module 15A:	Alternating Current Motors (Optional)	20-25
ELEC15B	Module 15B:	Alternating Current Motors (Optional)	10-20
ELEC16	Module 16:	Motor Starters and Controls (Optional)	20-40
ELEC17A	Module 17A:	Introduction to Electronic Components (Core)	10-20
ELEC17B,C	Module 17B, C:	Introduction to Electronics, Diodes (Optional)	5-8
★ELEC18A	Module 18A:	Cells and Small Voltage Sources (Core)	10-15
★ELEC18B	Module 18B:	Cells and Small Voltage Sources (Core)	5-10
★ELEC19A	Module 19A:	Measuring Instruments, Meters (Core)	5-10
★ELEC19B	Module 19B:	Measuring Instruments, Meters (Core)	4-7
ELEC20	Module 20:	Careers (Core)	2-5

ELEC33A,B,C	Module 33A, B, C: Work Study Preparation and Follow-up Activities (Optional)	5-10
ELEC34A,B,C	Module 34A, B, C: Work Study (Optional)	25-50
ELEC99A,B,C,D	Module 99A, B, C, D: Extended Study (Optional)	5-20

★ All sections of the starred modules must be completed thoroughly to meet the minimal theory requirements for students who will be taking the pure course and intend to challenge the Level 1 trade exam for the Electrician trade. Extensive practical assignments, that should include work study, will be necessary to ensure a successful challenge to the Level 1 apprenticeship examinations. See Appendix A*, Determining an Apprenticeship Route,* of this document for further details regarding preparation for apprenticeship. Refer to Appendix B*: Training Plans* for additional information regarding practical work experiences. In addition the modules DRAF31, from the Drafting and Computer-Assisted Design Curriculum guide, and CONS 03 and CONS 24, from the Construction and Carpentry Curriculum guide, are also required to complete Level 1 preparation.

Electronics Course Modules Overview

Module Code	Module		Suggested time (hours)
★ELEC01A	Module 1A:	Safety and Health (Core)	8-15
★ELEC01B,C,D	Module 1B, C, D:	Safety and Health (Core)	3-5
★ELEC02A	Module 2A:	Concepts About Electricity (Core)	10-20
★ELEC02B,C,D	Module 2B, C, D:	Concepts About Electricity (Core)	3-5
★ELEC03A,B	Module 3A, B:	Electrical Principles of Alternating Current Circuits and Transformers (Core)	5-8
★ELEC04A	Module 4A:	Wiring Circuits (Core)	15-25
★ELEC04B,C	Module 4B, C:	Wiring Circuits (Core)	3-5
★ELEC06	Module 6:	Conductors (Core)	5-10
★ELEC07A,B	Module 7A, B:	Overcurrent Devices (Core)	10-15
ELEC13A,B,C	Module 13A, B, C:	Alternating Current: Theory and Circuits (Core)	7-10
★ELEC14A	Module 14A:	Single Phase Power Transformers (Core)	10-20
★ELEC14B	Module 14B:	Single Phase Power Transformers (Core)	5-10
ELEC17A	Module 17A:	Introduction to Electronic Components (Core)	10-20
ELEC17B	Module 17B:	Introduction to Electronics, Diodes (Core)	5-8
ELEC17C	Module 17C:	Introduction to Electronics, Rectifiers (Core)	5-8
ELEC17D	Module 17D:	Introduction to Electronics, Rectifier Circuits (Core)	5-10
★ELEC18A,B	Module 18A, B:	Cells and Small Voltage Sources (Core)	10-15
★ELEC19A,B	Module 19A, B:	Measuring Instruments, Meters (Core)	5-10
ELEC20	Module 20:	Careers (Core)	3-5
ELEC21A	Module 21A:	Introductory Printed Circuit Board Fabrication (Optional)	5-10
ELEC21B	Module 21B:	Advanced Printed Circuit Board Fabrication (Optional)	8-10
ELEC22A, B	Module 22A,B:	Soldering, De-solderingand Recycling Components (Optional)	5-10
ELEC23A,B,C	Module 23:	Power Supplies (Core)	10-15
ELEC24A,B,C	Module 24A, B, C:	Transistor Theory (Core)	15-20
ELEC25	Module 25:	Integrated Circuits (Optional)	3-5
ELEC26A,B	Module 26A,B:	Tuned Circuits and Oscillators (Core)	15-20
ELEC27A	Module 27A:	Communications, Radio (Optional)	10-15
ELEC27B	Module 27B:	Communications, Antennas (Optional)	10-15
ELEC27C	Module 27C:	Communications, Fibre optics (Optional)	10-15
ELEC28	Module 28:	Ultrasonics (Optional)	8-15
ELEC29A,B,C	Module 29A, B, C:	Digital Concepts (Core)	10-15

ELEC30A,B,C	Module 30A, B, C:	Digital Circuits (Core)	10-15
ELEC31	Module 31:	Robotics (Optional)	5-10
ELEC32A,B	Module 32A, B:	Computer Recycling (Optional)	5-10
ELEC33A,B,C	Module 33A, B, C:	Work Study Preparation and Follow-up Activities (Optional)	5-10
ELEC34A,B,C	Module 34A, B, C:	Work Study (Optional)	25-50
ELEC99A,B,C,D	Module 99A, B, C, D	Extended Study (Optional)	5-20

Suggested Course Configurations: Electrical Route

Module Code	Modules		Suggested time (hours)
	Introductory Electrical, Electronics 10		
★ELEC01A	Module 1A:	Safety and Health (Core)	2-4
★ELEC02A	Module 2A:	Concepts about Electricity (Core)	5-8
★ELEC04A	Module 4A:	Wiring Circuits (Core)	5-8
★ELEC06	Module 6:	Conductors (Core)	3-5
★ELEC07A	Module 7A:	Overcurrent Devices (Core)	5-8
ELEC17A	Module 17A:	Introduction to Electronics (Core)	5-10
★ELEC18A	Module 18A:	Cells and Small Voltage Sources (Core)	5-8
★ELEC19	Module 19:	Measuring Instruments, Meters (Core)	5-10
ELEC22A	Module 22A:	Soldering, Desolderingand Recycling Components (Optional)	5-10
ELEC21A	Module 21A:	Introductory Circuit Board Fabrication (Optional)	10-15
★ELEC20	Module 20:	Careers (Core)	3-5
DRAF03	Module 3:	Sketching and Freehand Drawing Fundamentals (Optional)	5-10
ELEC99	Module 99:	Extended Study (Optional)	5-20
		Minimum	100 hours
	Intermediate Electrical 20		
★ELEC01B	Module 1B:	Safety and Health (Core)	Review-3
★ELEC02B	Module 2B:	Concepts about Electricity (Core)	Review-5
★ELEC03A	Module 3A:	Electrical Principles of Alternating Current Circuits and Transformers (Core)	5-8
★ELEC04B	Module 4B:	Wiring Circuits (Core)	5-8
★ELEC05A	Module 5A:	Basic Relays and Relay Circuits (Core)	4-7
★ELEC07B	Module 7B:	Overcurrent Devices (Core)	10-15
★CONS03	Module 3:	Basic Layout and Hand Tools (Optional)	5-8
★ELEC08A	Module 8A:	Residential Wiring Methods (Core)	5-8
DRAF13	Module 13:	Floor Plans (Optional)	5-10
ELEC17B	Module 17B:	Introduction to Electronics (Core)	Review 5-8
★ELEC18B	Module 18B:	Cells and Small Voltage Sources (Core)	5-8
★DRAF31	Module 31:	Reading Technical Drawings (Optional)	2-5
ELEC13A	Module 13A:	Alternating Current Theory and Circuits (Core)	7-10
ELEC33A	Module 33A:	Work Study Preparation and Follow-up Activities (Optional)	5-10
ELEC34A	Module 34A:	Work Study (Optional)	25-50
ELEC99	Module 99:	Extended Study (Optional)	5-20
		Minimum	100 hours
	Advanced Electrical A30		

★ELEC01C	Module 1C:	Safety and Health (Core)	Review-3
★ELEC02C	Module 2C:	Concepts about Electricity (Core)	Review-5
★ELEC04C	Module 4C:	Wiring Circuits (Core)	5-8
★ELEC05B	Module 5B:	Basic Relays and Relay Circuits (Core)	4-7
★ELEC08B	Module 8B:	Residential Wiring Methods (Core)	5-8
★ELEC09A	Module 9A:	Residential Circuits and Service (Core)	10-15
ELEC10A	Module 10A:	Direct Current Generators (Optional)	5-7
ELEC11A	Module 11A:	Direct Current Motors (Optional)	5-7
★ELEC12A	Module 12A:	Residential Lighting (Core)	5-10
ELEC13B	Module 13B:	Alternating Current Theory and Circuits (Core)	7-10
★ELEC14A	Module 14A:	Single Phase Power Transformers (Core)	5-10
ELEC15A	Module 15A:	Alternating Current Motors (Optional)	10-15
ELEC33B	Module 33B:	Work Study Preparation and Follow-up Activities (Optional)	5-10
ELEC34B	Module 34B:	Work Study (Optional)	25-50
ELEC99	Module 99:	Extended Study (Optional)	5-20
		Minimum	100 hours
	Advanced Electrical B30		
★ELEC01D	Module 1D:	Safety and Health (Core)	Review-3
★ELEC02D	Module 2D:	Concepts about Electricity (Core)	Review-5
★ELEC05C	Module 5C:	Basic Relays and Relay Circuits (Core)	4-7
★ELEC08C	Module 8C:	Residential Wiring Methods (Core)	5-8
★ELEC09B	Module 9B:	Residential Circuits and Service (Core)	15-25
ELEC10B	Module 10B:	Direct Current Generators (Optional)	5-8
ELEC11B	Module 11B:	Direct Current Motors (Optional)	5-8
ELEC13C	Module 13C:	Alternating Current Theory and Circuits (Core)	7-10
ELEC15B	Module 15B:	Alternating Current Motors (Optional)	10-15
★ELEC12B	Module 12B:	Residential Lighting (Core)	5-10
★ELEC14B	Module 14B:	Single Phase Power Transformers (Core)	5-10
ELEC16	Module 16:	Motor Starters and Controls (Optional)	10-20
ELEC33C	Module 33C:	Work Study Preparation and Follow-up Activities (Optional)	5-10
ELEC34C	Module 34C:	Work Study (Optional)	25-50
ELEC99	Module 99:	Extended Study (Optional)	5-20
		Minimum	100 hours

Suggested Course Configurations: Electronics Route

Module Code	Modules		Suggested time (hours)
	Introductory Electrical, Electronics 10		
ELEC01A	Module 1A:	Safety and Health (Core)	2-4
ELEC02A	Module 2A:	Concepts about Electricity (Core)	5-8
ELEC04A	Module 4A:	Wiring Circuits (Core)	5-8
ELEC06	Module 6:	Conductors (Core)	3-5
ELEC07A	Module 7A:	Overcurrent Devices (Core)	5-8
ELEC17A	Module 17A:	Introduction to Electronics (Core)	5-10
ELEC18A	Module 18A:	Cells and Small Voltage Sources (Core)	5-8
ELEC19A	Module 19A:	Measuring Instruments, Meters (Core)	5-10
ELEC21A	Module 21A	Introductory Circuit Board Fabrication (Optional)	10-15
ELEC22A	Module 22A	Soldering, Desolderingand Recycling Components (Optional)	5-10
ELEC20	Module 20:	Careers (Core)	3-5
DRAF03	Module 3:	Sketching and Freehand Drawing Fundamentals (Optional)	5-10
ELEC99	Module 99:	Extended Study (Optional)	5-20
		Minimum	100 hours
	Intermediate Electronics 20		
ELEC01B	Module 1B:	Safety and Health (Core)	Review-5
ELEC02B	Module 2B:	Concepts about Electricity (Core)	Review-5
ELEC03A	Module 3A:	Electrical Principles of Alternating Current Circuits and Transformers (Core)	Review 5-10
ELEC07B	Module 7B:	Overcurrent Devices (Core)	5-8
ELEC13A	Module 13A:	Alternating Current Theory and Circuits (Core)	5-8
ELEC14A	Module 14A:	Single Phase Power Transformers (Core)	5-10
ELEC17B	Module 17B:	Introduction to Electronics (Core)	Review - 5
ELEC19B	Module 19B:	Measuring Instruments, Meters (Core)	Review - 5
ELEC22B	Module 22B	Soldering, Desolderingand Recycling Components (Optional)	Review - 5
ELEC23	Module 23:	Power Supplies (Core)	15-25
ELEC24A	Module 24A:	Basic Transistor Theory (Core)	10
ELEC26A	Module 26A:	Tuned Circuits and Oscillators (Core)	15
ELEC27	Module 27:	Radio Communications (Optional)	20-25
ELEC28	Module 28:	Ultrasonics (Optional)	3-5
ELEC32A	Module 32A:	Computer Recycling (Optional)	5-8
ELEC33A	Module 33A:	Work Study Preparation and Follow-up Activities	5-10-

		(Optional)	
ELEC34A	Module 34A:	Work Study (Optional)	25-50
ELEC99	Module 99:	Extended Study (Optional)	5-20
		Minimum	100 hours
		Advanced Electronics A30	
ELEC01C	Module 1C:	Safety and Health (Core)	Review - 5
ELEC02C	Module 2C:	Concepts About Electricity (Core)	Review - 5
ELEC03B	Module 3B:	Electrical Principles of Alternating Current Circuits and Transformers (Core)	5-8
ELEC13B	Module 13B:	Alternating Current Theory and Circuits (Core)	10-15
ELEC17C	Module 17C:	Introduction to Electronics (Core)	Review - 5
ELEC19C	Module 19C:	Measuring Instruments, Meters (Core)	Review - 5
ELEC21	Module 21	Printed Circuit Board Fabrication (Optional)	Review - 5
ELEC24B	Module 24B:	Basic Transistor Theory (Core)	Review - 5
ELEC25	Module 25:	Integrated Circuits (Optional)	15
ELEC26B	Module 26B:	Tuned Circuits and Oscillators (Core)	20
ELEC29A	Module 29A:	Digital Concepts (Core)	15-20
ELEC30A	Module 30A:	Digital Circuits (Core)	15-20
ELEC32B	Module 32B:	Computer Recycling (Optional)	Review - 5
ELEC33B	Module 33B:	Work Study Preparation and Follow-up Activities (Optional)	5-10
ELEC34B	Module 34B:	Work Study (Optional)	25
ELEC99	Module 99:	Extended Study (Optional)	5-20
		Minimum	100 hours
		Advanced Electronics B30	
ELEC01D	Module 1D:	Safety and Health (Core)	Review - 5
ELEC02D	Module 2D:	Concepts About Electricity (Core)	Review - 5
ELEC13C	Module 13C:	Alternating Current Theory and Circuits (Core)	10-15
ELEC17D	Module 17D:	Introduction to Electronics (Core)	Review -5
ELEC27A	Module 27A:	Communications, Radio (Optional)	10-15
ELEC27B	Module 27B:	Communications, Antennas (Optional)	10-15
ELEC27C	Module 27C:	Communications, Fibre Optics (Optional)	10-15
ELEC29B	Module 29B:	Digital Concepts (Core)	10-15
ELEC29C	Module 29C:	Digital Concepts (Core)	10-15
ELEC30B	Module 30B:	Digital Circuits (Core)	10-15
ELEC30C	Module30C:	Digital Circuits (Core)	10-15

ELEC33C	Module 33C:	Work Study Preparation and Follow-up Activities (Optional)	5-10-
ELEC34C	Module 34C:	Work Study (Optional)	25-50
ELEC99	Module 99:	Extended Study (Optional)	5-20
		Minimum	100 hours

Module 1A: Safety and Health (Core)

Suggested time: - 15 hours **Level:** Introductory
Prerequisite: None

Foundational Objectives
- To work safely and cooperatively with other students and handle materials in a safe manner.
- To demonstrate the safe use and knowledge of meters and hand and power tools used in the electrical industry.

Common Essential Learnings Foundational Objectives
- To identify and practise safety precautions and procedures when working with electricity. (IL, CCT)
- To be aware of WHMIS procedures and standards as they apply to electricity. (COM)

	Learning Objectives	Notes
1.1	To identify and use personal safety equipment. (CCT)	Identify protective clothing, footwear, eye wear and ear wear that is needed for work site, school or home.
1.2	To select and operate a fire extinguisher. (IL, PSVS)	Discuss the different fire situations and which class of fire extinguisher is needed to put out each type of fire. Know the location of fire extinguishers in the shop. Practise putting fires out in a controlled setting.
1.3	To practise good housekeeping and avoid obvious hazards. (IL)	Students should work safely and practise all safety rules.
1.4	To use hand tools safely. (IL)	Display all of the tools relevant for use in electrical work that are in the shop. Demonstrate the proper way to use them. Select the proper tool for the given job.
1.5	To identify basic electrical hazards. (CCT)	Inspect all tools and electrical equipment for hazards before using them. Be sure to include extension cords.
1.6	To identify safe current voltage values. (NUM)	Students must understand body resistance and the amount of current that could be fatal. Check body resistance with an ohmmeter, then calculate how much voltage is needed to create a 50 milliampere (ma) of current.
1.7	To select and use appropriate electrical test equipment.	Under controlled conditions in the shop, practise taking electrical readings with the proper meter. Demonstrate the proper way to use electrical test equipment.
1.8	To follow first-aid procedures in case of electrical shock.	Review first aid procedures for bleeding wounds, burns and electrical shocks.

	Learning Objectives	Notes
1.9	To follow WHMIS procedures. (COM)	Review WHMIS procedures for handling hazardous materials. Make sure students understand warning labels and information sheets when following WHMIS. Refer to Saskatchewan Labour web site at http://www.labour.gov.sk.ca/safety/fast/WHMIS.HTM
1.10	To follow electrical code standards for the design and construction of circuits. (COM)	Use the current issue of the federal and provincial resources defining electrical code when doing any electrical work. Discuss the role of the electrical inspector.
1.11	To plan an electrical project or task and identify hazards.	Stress safety throughout the course. All projects must follow safety procedures and rules.
1.12	To identify hazards in the shop or workplace.	Have the students examine the shop area and determine potential hazards that might occur while working in the area.
1.13	To develop a plan of action in case of an accident. (COM)	Discuss appropriate actions in case of an accident (e.g., who to contact, where fire extinguisher is located, emergency exit route, first-aid procedures, etc.)
1.14	To follow lockout procedures and verify that a circuit is de-energized.	Review lockout procedures. With the help of a voltage tester, practise testing voltage in an energized and de-energized circuit.
1.15	To select and use appropriate hand and power tools and personal safety equipment.	Stress safety objectives continually. Students should be made aware of injuries that could occur if selection or use of tools is improper. Inspect all tools before using.
1.16	To identify the dangers of working on a ladder and precautions that should be taken. (COM)	Students should be instructed on the proper procedures of using a ladder. Discuss the dangers associated with working with a ladder.
1.17	To identify hazardous materials and follow WHMIS procedures. (CCT, IL)	Students should be aware of dangerous material and be watching for these materials throughout the course.
1.18	To apply electrical standards and codes.	Follow the standards and code rules with all jobs in accordance with the Occupational Health and Safety Act and federal and provincial resources defining electrical code. Refer to the *Practical and Applied Arts Handbook* for Saskatchewan Labour modules that discuss issues applying to safety.

Module 1B: Safety and Health (Core)

Review or repeat Module 1A as required before progressing to the next module at the B20 level

Suggested Time: 3 - 5 hours **Level:** Intermediate

Module 1C: Safety and Health (Core)

Review or repeat Module 1A as required before progressing to the next module at the A30 level

Suggested Time: 3 - 5 hours **Level:** Advanced

Module 1D: Safety and Health (Core)

Review or repeat Module 1A as required before progressing to the B30 level.

Suggested Time: 3 - 5 hours **Level:** Advanced

Module 2A: Concepts About Electricity (Core)

Suggested time: 10 - 20 hours **Level:** Introductory
Prerequisite: None

Foundational Objectives
- To use appropriate terminology for electricity or electronics in context.
- To demonstrate the safe use and knowledge of meters and hand and power tools used in the electrical industry.
- To be knowledgeable and skilled with different materials and devices and their application in the electricity and electronics field.

Common Essential Learnings Foundational Objectives
- To define and use electrical terms in context. (CCT)
- To understand electron theory and electrical terms such as insulator, conductor, dynamic electricity, and series and parallel circuits. (COM)
- To calculate voltages, current and resistance using Ohm's Law and Watt's Law, in electrical circuits that are in simple circuits, series circuits in parallel circuits. (NUM)

Note: Other CELs may be emphasized.

	Learning Objectives	Notes
2.1	To identify and describe the components of the design process.	Have the students describe the processes for each step in the design process. Additional information about the design process may be found in the Design Studies Curriculum Guide in Module 1.
		ELECTRON THEORY
2.2	To define common electrical terms. (COM)	Definitions should include: • Voltage - electromotive force • Current - the flow of electricity • Resistance - the opposition to current flow • Units of measurements - volts, amperes, ohms • Ohm's Law.
2.3	To understand attraction and repulsion of electrically charged objects.	Demonstrate that like charges repel and unlike charges attract. Demonstrate electrical field lines penetrating different material.
2.4	To understand the parts of an atom.	Work with students to: • Identify material by atomic structure as an insulator, a conductor or a semi-conductor • Define positive and negative ions • Explain free electrons • State the charges on each part of the atom • Note that there are sub-atomic particles other than protons, neutrons and electrons.

	Learning Objectives	Notes
		INSULATORS AND CONDUCTORS
2.5	To understand the characteristics of materials that act as conductors, insulators and semi-conductors.	Identify valence shell of conductors. List different materials that act as conductors. An activity to test current flow through various materials can be developed. Draw the Bohr model of atomic structure. Insulators: • Identify different materials as insulators. • Examine the atomic structure of an insulator. Semi-conductors: • Identify different materials as semi-conductors. • Study the atomic structure of a semi-conductor. • Examine the effect heat has on semi-conductor materials. • Compare the atomic structure of the different semi-conductor materials. • Explain that conductivity is a continuum, different materials conduct or resist differently.
		DYNAMIC ELECTRICITY
2.6	To define electromotive force, current and resistance. (NUM, COM)	Students will explain the relationship between voltage current and resistance Ohm's Law is: V=IxR • Voltage (V) = Current (I) x Resistance (R).
2.7	To solve Ohm's Law. (NUM)	Calculate voltage, current and resistance when given different simple circuits. Wire simple circuits, taking voltage, current and resistance readings.
2.8	To solve Watt's Law. (NUM)	Define electrical power. Use power formula to solve power output problems. Power (W)=Voltage (V) x Current (I) Calculate the power rating for equipment connected in series and parallel. Calculate power loss and transmission efficiency.

	Learning Objectives	Notes
		SERIES CIRCUITS
2.9	To understand voltage, current and resistance in a series circuit. (NUM, CCT)	Students will observe and identify the characteristics of voltage, current and resistance in a series circuit and calculate values by doing the following: • wire a series circuit and look at the characteristics of voltage, current and resistance by connecting meters to these circuits. • use series circuits with known values to calculate the unknown values using the appropriate equations. • observe different circuits and determine which one is a series circuit.
		PARALLEL CIRCUITS
2.10	To understand the characteristics of voltage, current and resistance in a parallel circuit.	Students will look at the characteristics of voltage, current and resistance in a parallel circuit and calculate values.
2.11	To interpret values measured in a parallel circuit. (NUM)	Students should wire a parallel circuit and look at the characteristics of voltage, current and resistance by connecting meters to these circuits.
2.12	To determine voltage, current and resistance values in a parallel circuit. (NUM)	Give students parallel circuits with known values and have them calculate the unknown values using the appropriate equations.
2.13	To identify a parallel circuit. (CCT)	Observe different circuits and determine which one is a parallel circuit.

Module 2B: Concepts About Electricity (Core)

Review or repeat Module 2A as required before progressing to the next module at the 20 level

Suggested Time: 3 - 5 hours **Level:** Intermediate

Module 2C: Concepts About Electricity (Core)

Review or repeat Module 2B as required before progressing to the next module at the A30 level

Suggested time: 3 - 5 hours **Level:** Advanced

Module 2D: Concepts About Electricity (Core)

Review or repeat Module 2C as required before progressing to the next module at the B30 level

Suggested time: 3 - 5 hours **Level:** Advanced

Module 3A: Electrical Principles of Alternating Current Circuits and Transformers (Core)

Suggested time: 5 - 8 hours **Level:** Intermediate
Prerequisites: Module 1, 2

Foundational Objectives
- To use appropriate terminology for electricity or electronics in context.
- To demonstrate the safe use and knowledge of meters and hand and power tools used in the electrical industry.
- To be knowledgeable about the different materials and devices and their application in the electrical field.

Common Essential Learnings Foundational Objectives
- To understand alternating current and transformers. (COM)
- To understand and calculate alternating current. (NUM)
- To apply knowledge in constructing a basic transformer. (IL)

Note: Other CELs may be emphasized.

	Learning Objectives	Notes
	ALTERNATING CURRENT (AC)	
3.1	To define alternating current (AC). (CCT)	Discuss with students the various AC sources.
3.2	To explain the difference between alternating current (AC) and direct current (DC). (COM)	Students may draw common AC and DC wave forms.
3.3	To define values related to current or voltage on a given sine wave. (IL, NUM)	With the help of an oscilloscope, students will determine values of a given sine wave, peak (pk), peak to peak (pk to pk), Root Mean Square (RMS).
3.4	To define terms that are related to a sine wave. (COM)	Students should observe a sine wave and label the different parts (cycle, alternations, period and frequency).
3.5	To explain the advantages of using AC.	Students may research areas where AC is being used and explain why. Discuss the generator principle. The history of the competition between supporters of DC and AC in the early days of electrical utilities is very interesting. It could be an opportunity for student research.

Module 3B: Electrical Principles of Alternating Current Circuits and Transformers (Core)

Suggested time: 5 - 8 hours **Level:** Advanced
Prerequisites: Modules 1, 2

	Learning Objectives	Notes
		BASIC TRANSFORMERS
3.6	To understand the operation of a transformer.	Describe and discuss the electrical properties of induction. Explain basic transformer action. Construct a simple transformer.
3.7	Identify different types of transformers. (IL, CCT)	Student should identify different transformers (i.e., step-up, step-down, isolation transformers) and explain where they would be used. Students may list several uses for transformers.
3.8	Explain the *turns ratio* and its effect on voltage and current. (NUM)	Students use the basic *turns ratio formula* to calculate current and voltage. When: *Np* is the number of turns in the primary winding *Ns* is the number of turns in the secondary winding *Vp* is the voltage in the primary winding *Vs* is the voltage in the secondary winding *Is* is the current in the secondary winding *Ip* is the current in the primary winding $\frac{N_p}{N_s} = \frac{V_p}{V_s}$ $\frac{V_p}{V_s} = \frac{I_s}{I_p}$

Module 4A: Wiring Circuits (Core)

Suggested time: 15 - 25 hours **Level:** Intermediate
Prerequisite: Module 3A

Foundational Objectives
- To use appropriate terminology for electricity or electronics in context.
- To read, understand and interpret schematic diagrams and other technical documents.
- To be knowledgeable about the various principles and characteristics of electrical and electronics.

Common Essential Learnings Foundational Objectives
- To understand, explain and apply the principles of basic electric circuitry. (COM, CCT)
- To follow code rules and safety practices required in all activities. (IL)
- To apply the principles of electrical circuitry. (TL)

	Learning Objectives	Notes
		AC POWER SYSTEMS
4.1	To understand and compare a neutral wire, a hot wire and a ground wire. (COM, CCT)	Review different AC circuits. Hook up a simple circuit and with the help of multimeter explain why a ground wire is being used. Research the characteristics of lightning and explain why lightning arresters are used.
4.2	To understand the 120/240 volt three-wire systems. (COM, NUM)	Draw a schematic diagram and label all wires in the three-wire system. Observe a three-wire system, as a demonstration for the students. With the help of a multimeter, have students check different voltages and explain their answers.
		CIRCUITS
4.3	To draw a simple circuit.	Draw a simple circuit and label all the parts (load, source, etc.)
4.4	To define a short circuit. (COM)	Students should look at examples of equipment that has been short-circuited and discuss what they see.
4.5	To draw schematic and wiring diagrams for different electrical circuits. (IL)	Have students examine different circuits. Have them draw and label the schematic and wiring diagrams (e.g., single pole switch, three-way switch, four-way switch and duplex receptacles).

	Learning Objectives	Notes
	ELECTRICAL CIRCUIT INSTALLATION	
4.6	To list electrical code rules that apply to a given situation. (COM, CCT)	Give students several examples of specific circuits and have them: • identify the code rules that pertain to each circuit • determine the tools that will be needed for certain jobs • determine which electrical components will be needed.
4.7	To install a branch circuit using the proper hand tools and electrical components required. (CCT)	Review the types of screwdrivers and pliers required to complete the task. Students must follow the most recent federal and provincial resources defining electrical codes that are published every four years.
4.8	To assemble different circuits given the required components. (IL)	Have students install the following circuits: • duplex receptacles • single pole switch controlling a light • three-way switches controlling a light • four-way switches controlling a light. Have students wire any combination of the above circuits.

Module 4B: Wiring Circuits (Core)

Review or repeat Module 4A as required before progressing to the next module at the 20 level

Suggested time: 3 - 5 hours **Level:** Intermediate

Module 4C : Wiring Circuits (Core)

Review or repeat Module 4B as required before progressing to the next module at the A30 level

Suggested time: 3 - 5 hours **Level:** Advanced

Module 5A: Basic Relays and Relay Circuits (Core)

Suggested time: 3 - 5 hours **Level:** Intermediate
Prerequisite: Module 2

Foundational Objectives
- To apply the principles of magnetism to electrical devices. (TL)
- To be knowledgeable of the various principles and characteristics of electricity and electronics.

Common Essential Learnings Foundational Objectives
- To understand the concept of magnetism and its electrical applications. (COM)
- To use appropriate terminology for electricity or electronics in context. (COM)

Note: Other CELs may be emphasized.

	Learning Objectives	Notes
		MAGNETISM
5.1	To state the characteristics of a magnetic field. (COM)	Preview some common magnetic terms. Have students work with different types of magnets (e.g., temporary, permanent, natural) and experiment with iron filings.
5.2	To explain the interaction of magnetic fields.	Using correct terminology, have students explain various interactions.
5.3	To explain the phenomenon of an electromagnetic field around a current carrying conductor.	Students will connect a current carrying wire and a compass or iron filings to demonstrate the magnetic field.
5.4	To state the factors that change the strength of an electromagnetic field. (IL)	
5.5	To state the *left-hand rule* for current flow.	Have students experiment to prove the left hand rule.
5.6	To explain the "solenoid" effect of an iron core in an electromagnetic field.	Have students experiment to prove the effect of electricity on an iron core. For example, have students create a simple electromagnet with a bolt, copper wire and a battery to pick up small nails.

Module 5B: Basic Relays and Relay Circuits (Core)

Suggested time: 3 - 5 hours **Level:** Advanced
Prerequisite: Module 5A

	Learning Objectives	Notes
		BELL AND CHIME CIRCUITS
5.7	To understand the operation of a buzzer and a bell.	Students may draw a wiring and schematic diagram for a buzzer and bell circuit. Wire a buzzer and a bell circuit.
5.8	To understand the operation of a common residential door chime. (IL)	Have students wire a door chime from two locations. Students may then draw a wiring and schematic diagram for a two station door chime circuit.
5.9	To identify the operating principles of a basic signal system.	Have the students draw a schematic diagram of a basic signal system, then wire the basic signal system using all the applicable electrical code rules. (TL)

Module 5C: Relays and Relay Circuits (Core)

Suggested time: 3 – 5 hours **Level:** Advanced
Prerequisite: Module 5B

	Learning Objectives	Notes
		RELAYS AND RELAY CIRCUITS
5.10	To understand and create a small magnetic relay.	Students wire a magnetic relay into an electrical circuit. Draw a wiring and schematic diagram of a magnetic relay in an electrical circuit. Have the students identify and wire a remote control relay following the current code rules.
5.11	To understand and create a stop-start momentary contact switch.	Students may draw a schematic diagram of a stop-start momentary contact switch. Have students wire a stop-start momentary contact switch controlling some type of electrical device.
		ADVANCED RELAY CIRCUITS
5.12	To explain the operation of multi-use magnetic relays.	Have students wire extra low voltage lighting using relays.

Module 6: Conductors (Core)

Suggested time: 5 - 10 hours **Level:** Introductory
Prerequisite: Module 2

Foundational Objectives
- To use appropriate terminology for electricity or electronics in context.
- To be knowledgeable and skilled with different materials and devices and their application in the electricity and electronics field.

Common Essential Learnings Foundational Objectives
- To describe common conductors and how they are used in the electrical trade. (COM)
- To make calculations related to different conductors. (NUM)

	Learning Objectives	Notes
6.1	To understand the effect of insulation on the ampacity of a conductor. (CCT)	Students identify different insulating materials and how circuit voltage, temperature and use/situation have an effect on the ampacity.
6.2	To identify uses for different conductor types. (COM)	Look at the uses for cables, cords and printed circuit boards.
6.3	To determine the American Wire Gauge (AWG) number of a conductor. (NUM)	Demonstrate how to use a wire gauge to determine different wire sizes. Have students convert rectangular or square dimensional conductors to equivalent circular mil area measured in square millimeters. Students should calculate: • differences between circular mils, square mils and square millimeters • line losses and line voltage drops • allowable conductor sizes and ampacities.
6.4	To determine bonding conductors.	As bonding refers to a method of fusing different conductors together students should: • identify bonding requirements • identify common bonding methods • determine common conductor sizes.
6.5	To be able to terminate conductors.	Students can prepare different types of conductors for termination, using solderless connectors, screw and lug connectors, and solder connections (see Module 22). Have the students build extension cords using attachment caps and cord connectors.

Module 7A: Overcurrent Devices (Core)

Suggested time: 10 - 15 hours **Level:** Introductory
Prerequisites: Modules 2, 6

Foundational Objectives
- To be knowledgeable and skilled with different materials and devices and their application in the electricity and electronics field.
- To demonstrate the safe use and knowledge of meters and hand and power tools used in the electrical industry.

Common Essential Learnings Foundational Objectives
- To understand and describe the different types of circuit protection devices that are used in the electrical trade. (COM)
- To use appropriate testing equipment. (TL)

	Learning Objectives	Notes
		FUSES
7.1	To understand how a fuse works and explain its purpose. (COM)	Referring to Ohm's Law, discuss with students what is an overloaded circuit. Discuss what would happen in a short circuit situation. Students should wire a fuse in an electrical circuit. Using a tester, have students troubleshoot a circuit with a fuse in it.
7.2	To identify different types of fuses.	Examine different fuse types (e.g., plug fuses, cartridge fuses, time-delay fuses, renewable fuses) and explain their use. Have the students calculate the fuse rating for a given circuit.
		CIRCUIT BREAKERS
7.3	To demonstrate the current flow through a circuit breaker.	Have students wire an electrical circuit using a circuit breaker. Students should draw a schematic diagram showing current flow.
7.4	To identify the bi-metallic strip that is used in a breaker.	Have students take a breaker apart and explain all the parts.
7.5	To select the correct size of circuit breaker for specific loads. (NUM)	Using Ohm's Law, have students calculate the right size breaker for a circuit. Observe the different types of breakers used for different purposes (e.g., double pole single throw).

Module 7B: Overcurrent Devices (Core)

Suggested time: 10 - 15 hours **Level:** Intermediate

Prerequisite: Module 7A

	Learning Objectives	Notes
	GROUND FAULT INTERRUPTERS	
7.6	To understand the use of a Ground Fault Interrupter (GFI) in a circuit. (TL)	Review operation of a GFI. Using the current federal and provincial resources defining electrical codes students will find where GFIs should be used. Have students examine a GFI. Investigate situations where GFIs can be installed at the receptacle.
7.7	To demonstrate the correct placement of a GFI in an electrical circuit.	Indicate the colour coding differences for the feed through side and the down stream side of the GFI.

Module 8A: Residential Wiring Methods (Core)

Suggested time: 10 - 15 hours **Level:** Intermediate
Prerequisites: Modules 1, 2, 3, 4, 5, 6, 7

Foundational Objectives
- To read and interpret schematic diagrams and other technical documents.
- To be knowledgeable and skilled with different materials and devices and their application in the electricity and electronics field.
- To design and/or build circuits to an acceptable standard capable of producing a desired output.

Common Essential Learnings Foundational Objectives
- To understand and use schematic and wiring diagrams of different electrical circuits. (TL)
- To apply knowledge and skills by wiring circuits. (CCT, IL)
- To work in a safe, cooperative manner in handling electrical materials. (PSVS)

	Learning Objectives	Notes
		OUTLET BOXES
8.1	To identify and name different types of outlet boxes used in residential wiring. (COM)	Students should look at all types of outlet boxes used in residential wiring.
8.2	To select the correct type of box and cover used in residential wiring. (IL)	Using the current federal and provincial resources defining electrical codes, have students determine which box and cover should be used for a given situation. Wire different outlet boxes for the job assigned.
8.3	To calculate the maximum number of wires allowed in an outlet box. (NUM)	Determine box fill using current federal and provincial electrical codes. Students should discuss the different factors that determine box fill.
		NON-METALLIC SHEATHED CABLE
8.4	To identify the different types of non-metallic sheathed cable. (CCT)	Using current, federal electrical codes, students will determine the different types of non-metallic sheathed cable and where this cable can be used.
8.5	To identify the different types of connectors and fasteners used with non-metallic sheathed cable.	
8.6	To install branch circuits using receptacles, lights and different switching circuits in accordance with current federal electrical codes.	Have students wire the following circuits with non-metallic sheathed cable: • duplex receptacles • split duplex receptacles • lights from one location • lights from two locations • lights from three locations • dryer plugs • range plugs.

Module 8B: Residential Wiring Methods, Sheathed Cable (Core)

Suggested time: 10 - 15 hours **Level:** Advanced
Prerequisite: Module 8A

	Learning Objectives	Notes
		ARMORED CABLE
8.7	To identify armored cable and the connectors and fastening devices used with this cable. (COM)	Review the section in accordance with the current federal and provincial electrical codes dealing with armored cable. Have students look at different circuits using armored cable and discuss why this cable is used. (PSVS)
8.8	To terminate armored cable at an outlet box properly. (IL)	Practise terminating cable.
8.9	To install a branch circuit using armored cable. (TL)	Have students install a branch circuit using armored cable according to the Canadian Electrical Code (CEC) Book.
		ALUMINUM SHEATH CABLE
8.10	To identify aluminum sheath cable type, applications and installation standards.	Have students identify aluminum sheath cable and have them install an electrical circuit using this cable.
		MINERAL INSULATED CABLE
8.11	To identify mineral insulated cable types, applications and installation standards.	Have students identify mineral insulated cable and have them install an electrical circuit using this cable.
		RACEWAYS
8.12	To identify conductors that are suitable for use in a raceway.	Have students discover the types of cables that can be used in a raceway. Have students find common rules used in raceway installations.
8.13	To calculate the number of conductors that can be used in a raceway.	Have students calculate the maximum number of conductors that can be used in different sized raceways.

Module 8C: Residential Wiring Methods, Conduit (Core)

Suggested time: 10 - 15 hours **Level:** Advanced
Prerequisite: Module 8B

	Learning Objectives	Notes
		CONDUIT
8.14	To identify the different types of conduits and the connectors and fasteners used.	Students should review the section in the Canadian Electrical Code (CEC) Book that deals with conduit types. Observe different circuits using conduit and discuss why it is used.
8.15	To explain the methods of bending various types of conduits.	Different conduit sizes and materials use different methods.
8.16	To make a bend on a piece of conduit.	Practise bending different types of curves in conduit. Use proper bending tools.
8.17	To install an electrical circuit using conduit.	Have students do wiring using conduit of some form (Rigid, EMT, PVC, Flexible Metal conduit, Metallic tubing, Rigid HFT conduit and surface raceways.)
8.18	To calculate the wire fill (capacity) for a specific size of conduit. (NUM, IL)	With the help of federal and provincial resources defining electrical code, have students determine conduit wire fill on different sizes of conduit.
		EXTRA-LOW VOLTAGE WIRING
8.19	To identify different remote control devices and explain how they work in a circuit.	Have students wire different extra-low voltage devices in the shop according to directions in accordance with the current federal and provincial electrical codes. Students may draw a schematic and wiring diagram of different low-voltage devices.
8.20	To identify different code rules that apply to extra-low voltage. (COM)	In accordance with the current federal and provincial electrical codes students should find all the rules that pertain to extra-low voltage.

Module 9A: Residential Branch Circuits and Services (Core)

Suggested time: 15 - 20 hours **Level:** Advanced
Prerequisite: Module 8

Foundational Objectives
- To read and interpret schematic diagrams and other technical documents.
- To design and/or build circuits to an acceptable standard capable of producing a desired output.
- To increase self-esteem from success with the equipment, materials and techniques used.
- To be knowledgeable of the various principles and characteristics of electricity and electronics.

Common Essential Learnings Foundational Objectives
- To understand the circuits used in residential wiring. (COM)
- To interpret blueprints and make decisions needed to provide electrical services to a residence. (CCT)
- To make calculations for branch circuits. (NUM)

	Learning Objectives	Notes
	RESIDENTIAL BRANCH CIRCUITS	
9.1	To identify the different circuits used in residential wiring. (COM)	Have students identify different branch circuits that are being used for residential wiring. Refer to *Drafting and Computer-Aided Design,* Module 31, Reading Technical Drawings, as an additional resource.
9.2	To calculate the current requirements of various sized loads. (NUM)	In accordance with the current federal and provincial electrical codes, have students calculate the different load sizes.
9.3	To select wire sizes for different branch circuits.	In accordance with the current federal and provincial electrical codes, have students determine wire sizes for different branch circuits.
9.4	To lay out all branch circuits showing all outlet boxes on a residential blueprint. (CCT, IL)	Examine several blueprints. Then have students design their own wiring/electrical layout following instructions in accordance with the current federal and provincial electrical codes
9.5	To determine the number of branch circuits required for a given residential service. (NUM, IL)	In accordance with the current federal and provincial electrical codes, have students determine the minimum number of branch circuits needed for residential service of a particular size.

Module 9B: Residential Circuit Layout (Core)

Suggested time: 15 – 25 hours **Level:** Advanced
Prerequisite: Module 9A

	Learning Objectives	Notes
		RESIDENTIAL WIRING LAYOUT
9.6	To calculate the service size for a given residence. (NUM)	Have students calculate a service size for a residence under $80m^2$. Calculate a service size for a residence over $80m^2$ with various types of loads.
9.7	To identify the various parts of a residential service.	Review all the parts and requirements of a residential service, (including panelboard size, service size, service overcurrent device, grounding requirement and bonding).
9.8	To wire, with supervision, a residential service. (TL)	Lay out and wire a residential service according to the guide, in accordance with the current federal and provincial electrical codes Modules 13, 24 and 31 from the *Drafting and Computer-Aided Design Curriculum Guide* are useful as a reference for this objective. Students should be able to install both an overhead service and an underground for a single family dwelling. In accordance with the current federal and provincial electrical codes, have students determine the proper size and type of circuit breaker needed for the residential service described.

Module 10A: Direct Current Generators, Basic Shunt (Optional)

Suggested time: 5 - 7 hours **Level:** Advanced
Prerequisite: Module 2

Foundational Objectives
- To use appropriate terminology for electricity or electronics in context.
- To test and evaluate the integrity of electrical and electronic components.
- To become knowledgeable of the various principles and characteristics of electricity and electronics.

Common Essential Learnings Foundational Objectives
- To identify the parts and understand the workings of different types of direct current generators. (COM)
- To connect different types of direct current generators to a circuit. (IL)
- To select the appropriate generator for a specific purpose. (CCT)

	Learning Objectives	Notes
		BASIC SHUNT GENERATORS **series and compound generators**
10.1	To understand how different generators work.	Compare self-excited generators and separately-excited generators.
10.2	To identify the windings and parts of the generator.	Students may study a disassembled generator and name all its parts. Using an ohmmeter, students should identify the different windings by their resistance.
10.3	To explain the conditions necessary for voltage build-up in a series generator.	Students will connect a series generator and, under a controlled setting, observe what will happen with no load.
10.4	To identify the windings in a series generator.	Students will study a disassembled series generator and label all the parts. Using an ohmmeter, have students identify the different windings.
10.5	To describe where a series generator may be used. (COM)	Students should discuss where a series generator may best be used.
10.6	To explain the various types of compound generator connections.	Students may connect different compound generators.
10.7	To describe where a compound generator may be used. (COM)	Discuss where a compound generator may best be used.
10.8	To explain commutation and its effect.	Students will wire up a generator and suggest why a commutator has to be used.

Module 10B: Direct Current Generators, Advanced Shunt (Optional)

Suggested time: 5 - 15 hours **Level:** Advanced
Prerequisite: Module 10A

	Learning Objectives	Notes
	ADVANCED SHUNT GENERATORS	
10.9	To connect a shunt generator with self-excited and separately-excited configuration. (IL)	Have the students wire shunt generators with self-excited and separately-excited configurations and observe the differences between the two types of generators.
10.10	To explain the relationship between the direction of rotation, field flux and the output polarity of a shunt generator. (CCT)	Have students wire a shunt generator and observe the effects of speed variation on load characteristics.
10.11	To explain power losses in a DC generator and calculate generator efficiency. (NUM)	Students will observe different DC generator readings and calculate power loss and efficiency.
10.12	To correctly connect a series generator to a loaded circuit. (IL)	Connect a series generator to a circuit with a load.
10.13	To plot a voltage regulation curve for a series generator. (NUM)	Connect a series generator to a suitable load and take the readings from the measuring instruments to collect data for a voltage regulation curve.

Module 11A: Direct Current Motors (Optional)

Suggested time: 5 - 15 hours **Level:** Advanced
Prerequisite: Module 10

Foundational Objectives
- To become knowledgeable about the different materials and devices and their application in the electrical field.
- To demonstrate the safe use and knowledge of meters and hand and power tools used in the industry.

Common Essential Learnings Foundational Objectives
- To understand how direct current (DC) motors work. (COM)
- To connect a DC motor and make decisions regarding its use. (TL, CCT)

	Learning Objectives	Notes
	SHUNT MOTORS	
11.1	To understand the basic operation of a shunt motor.	Students should examine a shunt motor and observe how it works.
11.2	To explain the effect of flux and armature current on torque. (NUM)	Students may experiment with a shunt motor.
11.3	To explain the effect and causes of counter Electro-Motive Force (EMF). (CCT)	
11.4	To explain the factors that determine the direction of rotation of a shunt motor.	
11.5	To list several applications of a shunt motor. (COM)	Through discussions, have students determine places where a shunt motor could be used.
	SERIES MOTORS	
11.6	To explain the operation of a series motor.	Have students examine a series motor and observe how it works.
11.7	To explain the factors that affect the direction of rotation of a series motor.	Students may experiment or test a series motor. (TL)
11.8	To list several applications of a series motor. (COM)	Through discussion, students determine places where a series motor could be used.

Module 11B: Direct Current Motors (Optional)

Suggested time: 5 - 15 hours **Level:** Advanced
Prerequisite: Module 10

	Learning Objectives	Notes
		COMPOUND MOTOR
11.9	To explain the operation of and connections for a compound motor. (COM)	Have students examine a compound motor and observe how it works.
11.10	To list several applications for a compound motor. (CCT)	Through discussion, have students determine places where a compound motor could be used.
11.11	To compare the operation of three types of motors.	Students may describe characteristics of the three types of DC motors: shunt, series and compound.

Module 12A: Residential Lighting (Core)

Suggested time: 15 - 25 hours **Level:** Advanced
Prerequisite: Module 8

Foundational Objectives
- To be knowledgeable and skilled with different materials and devices and their application in the electricity and electronics field.
- To work safely and cooperatively with other students and handle materials in a safe manner.
- To design and/or build circuits to an acceptable standard capable of producing a desired output.
- To use and interpret meter readings.

Common Essential Learnings Foundational Objectives
- To understand and install the different types of lighting circuits used in residential services. (TL)
- To assess the efficiency of various light sources. (PSVS, CCT)

	Learning Objectives	Notes
	RESIDENTIAL LIGHTING SOURCES	
12.1	To list the various methods of producing light.	Have students examine various types of lights (incandescent, fluorescent, high intensity). Examine the different types of bulb configurations.
12.2	To list the major parts of an incandescent light bulb.	Review the operation and operating principles of an incandescent light bulb.
12.3	To relate lamp life to line voltage for an incandescent bulb. (CCT)	Wire up a lighting circuit and observe what happens when voltage is decreased and increased.
12.4	To describe special purpose incandescent lamps. (COM)	Examine tri-lights, long-life, infrared, flood, halogenand rough service lamps.
12.5	To install a light fixture. (TL)	Install and connect different types of light fixtures.
12.6	To explain how a fluorescent lamp produces light. (COM)	Students should review the basic operating principles of the fluorescent tube and different types of fixtures.
12.7	To list the parts of a fluorescent lamp. (COM)	Disassemble a fluorescent lamp and examine the parts. List and explain the function of each part. **Caution:** Old fluorescent light fixtures may have ballasts that contain PCBs. They can be very hazardous if handled incorrectly. Observe proper precautions.

Module 12B: Residential Lighting (Core)

Suggested time: 5 - 10 hours **Level:** Advanced
Prerequisite: Module 12A

	Learning Objectives	Notes
	SPECIAL LIGHTING SOURCES	
12.8	To understand the production of light in a high intensity discharge lamp.	Explore the basic operating principles of a high intensity discharge lamp. Have students disassemble a high intensity discharge lamp.
12.9	To explain the light efficiencies of the different types of lights. (COM)	Compare the different types of lights and generate a list of efficiencies for each.
12.10	To wire a photoelectric cell.	Have the students wire a photoelectric cell to a lighting circuit to operate a lamp.
12.11	To describe the different characteristics of light and methods of measuring intensity. (NUM)	Students can discover a variety of methods to measure light. Show students how to determine the optimum light for a given application, then provide a variety of situations where students calculate the correct light intensity levels.

Module 13A: Alternating Current: Theory and Circuits (Core)

Suggested time: 7 - 10 hours **Level:** Intermediate
Prerequisite: Module 2A

Foundational Objectives
- To use appropriate terminology for electricity or electronics in context.
- To read and interpret schematic diagrams and other technical documents.
- To increase self-esteem from success with the equipment, materials and techniques used.
- To be knowledgeable of the various principles and characteristics of electricity and electronics.

Common Essential Learnings Foundational Objectives
- To understand the principles of resistance, capacitance and inductance in an AC circuit. (TL)
- To use the vocabulary and make calculations related to alternating current (AC) circuits. (COM, NUM)

Note: Other CELs may be emphasized.

	Learning Objectives	Notes
		ALTERNATING CURRENT
13.1	To define the process known as electromagnetic induction. (COM)	Students should observe and describe the generator principle.
13.2	To list the three factors that affect the voltage induced in a wire.	Experiment with voltage being induced in a wire. (TL)
13.3	To understand a sine wave. (NUM)	Students calculate pk, pk to pk and RMS for differences in sine waves. Discuss a sine wave and how it functions. Draw a sine wave and label all the parts. Refer to Module 3 for review of terminology for oscilloscopes.

Module 13B: Alternating Current: Theory and Circuits (Core)

Suggested time: 7 - 10 hours **Level:** Advanced
Prerequisites: Modules 2, 13A

	Learning Objectives	Notes
		CAPACITOR CIRCUITS
13.4	To explain what a capacitor is, how it works and how it is rated. (COM)	Students will observe different capacitors and the instructor will describe how they are constructed and rated. Connect a capacitor in a circuit and observe what happens.
13.5	To list factors that affect capacitance.	Wire different capacitors in electrical circuits in which students can control the different settings.
13.6	To calculate total capacitance in a circuit.	Connect capacitors in series, parallel and combination and have students determine total capacitance. Calculate total capacitance in different capacitance circuits.
13.7	To calculate the power used in a capacitive circuit. (NUM)	Have students solve various problems concerning power in a capacitive circuit.
13.8	To explain phase shift and power factor. (COM, NUM)	Students should observe what happens in a circuit when capacitors are added to lower the power factor.

Module 13C: Alternating Current: Theory and Circuits (Core)

Suggested time: 7 - 10 hours **Level:** Advanced
Prerequisites: Modules 2, 13B

	Learning Objectives	Notes
13.9	To explain what is an inductor. (COM, IL)	Students observe a circuit containing an inductor.
13.10	To list the factors that affect inductance and the basic units of inductance.	Examine different electrical circuits.
13.11	To calculate the inductive reactance in an AC circuit. (NUM)	Calculate inductive reactance in different circuits.
13.12	To calculate the power factor.	Determine power being used in the circuits above.

Module 14A: Single Phase Power Transformers (Core)

Suggested time: 10 - 20 hours **Level:** Advanced
Prerequisites: Modules 2, 13

Foundational Objectives
- To be knowledgeable and skilled with different materials and devices and their application in the electricity and electronics field.
- To test and evaluate the integrity of electrical and electronic components.

Common Essential Learnings Foundational Objectives
- To understand and describe transformer operation, turns ratio, voltage ratio and current ratio. (COM)
- To make necessary calculations on power usage. (NUM)
- To make appropriate decisions regarding the use of transformers. (TL, CCT)

	Learning Objectives	Notes
		POWER TRANSFORMERS
14.1	To define mutual inductance and transformer ratios. (COM)	Students observe how electromagnetic induction occurs between two coils.
14.2	To identify the high voltage and low voltage leads.	Using an ohmmeter, have students identify different transformer leads. Identify the different markings on a transformer that indicate high and low voltage leads.
14.3	To calculate the voltage, current and turn ratio on the transformer. (NUM)	Using several examples, students should calculate voltage, current and turn ratios.

Module 14B: Single Phase Power Transformers (Core)

Suggested time: 5 - 10 hours **Level:** Advanced
Prerequisites: Modules 2, 13, 14A

	Learning Objectives	Notes
14.4	To connect a load to a transformer. (NUM)	Calculate efficiency of several electrical circuits using transformers. Use examples to calculate efficiency given the appropriate load, current, resistance and power losses.
14.5	To explain transformer impedance matching. (CCT)	Have students experience the process involved in transformer impedance matching to determine transformer use.
14.6	To identify the different types of transformers and explain their use. (IL)	Students will experiment with different types of transformers and determine how they might be used.
14.7	To troubleshoot transformers. (PSVS)	Check out different transformers to determine if they are working. Observe necessary safety precautions.

Module 15A: Alternating Current Motors (Optional)

Suggested time: 20 – 25 hours **Level:** Advanced
Prerequisites: Modules 2, 13

Foundational Objectives
- To analyze circuits and predict the output.
- To increase self-esteem from success with equipment, materials and techniques used.
- To become knowledgeable of the various principles and characteristics of electricity and electronics.
- To use appropriate terminology for electricity or electronics in context.
- To demonstrate the safe use and knowledge of meters and hand and power tools used in the electrical industry.

Common Essential Learnings Foundational Objectives
- To understand electromagnetic induction and its application to the use of motors.
- To identify and work with various types of fractional horsepower motors. (TL)
- To work safely and cooperatively with others. (PSVS)

	Learning Objectives	Notes
	INDUCTION MOTORS	
15.1	To explain the motor operating principle of an induction motor. (COM)	Using an induction motor, examine inductance and the interaction of magnetic fields.
15.2	To explain the principle of starting used in split phase motors.	Students may take apart a split phase motor and examine how it works.
15.3	To identify the parts of a split phase motor.	
15.4	To list several types of split phase induction motors. (COM)	Students review and examine the different types of split phase motors. Students will match motor type to appropriate purpose.
15.5	To draw schematic diagrams of different types of split phase induction motors. (IL)	Students may disassemble several types of motors and draw schematic diagrams based on what they discover.
15.6	To identify the leads on a split phase motor.	Using a multimeter, students take apart a motor and identify the different leads. (PSVS)

	Learning Objectives	Notes
15.7	To connect and run a split phase motor. (TL)	Have students wire a split phase motor to the correct voltage. Students will reverse the direction of the motor rotation by changing the direction of current flow.
15.8	To identify safety devices used on induction motors. (CCT, NUM)	Identify internal overload devices on a motor. Determine the size of overload needed for a given motor.
15.9	To perform basic trouble-shooting on an AC motor. (CCT, PSVS)	Use the appropriate meters to determine problems students may encounter on certain motors. Students should understand the importance of the cooling systems and the enclosures of certain motors.

Module 15B: Alternating Current Motors (Optional)

Suggested time: 10 – 20 hours **Level:** Advanced
Prerequisites: Modules 2, 13

	Learning Objectives	Notes
		SHADED POLE MOTOR
15.10	To identify the shading coil in a shaded pole motor. (CCT)	Students should take a shaded pole motor apart and label all the parts. (PSVS) Use a meter to identify the different windings on a shaded pole motor.
15.11	To explain the principles of operation in a shaded pole motor. (COM)	Using a shaded pole motor, explain how the rotating field is created.
15.12	To draw a schematic diagram of a shaded pole motor. (COM)	Have students draw the schematic wiring diagram of a shaded pole motor. Students wire a shaded pole motor to the appropriate voltage. Students will reverse the direction of the motor rotation by changing current direction. Compare the starting torque of the shaded pole motor to that of a split phase motor.
		UNIVERSAL MOTOR
15.13	To explain the operation of an AC universal motor compared to a series DC motor.	Students should take apart a universal AC motor and compare it with a DC series motor.
15.14	To identify the parts and windings of a universal motor.	Have students take apart a universal motor and draw a schematic diagram of it.
15.15	To connect a universal motor to the correct operating voltage. (TL)	Connect a universal motor to proper current source. Demonstrate, in a controlled setting, what would happen if a load was no longer attached to the motor. Change the direction of rotation of the motor.
15.16	To compare starting torque of a universal motor with that of an induction motor. (CCT)	
15.17	To list several uses for a universal motor. (COM)	Discuss with students where a universal motor may be used.

Module 16: Motor Starters and Control (Optional)

Suggested time: 20 – 40 hours **Level:** Advanced
Prerequisites: Modules 14, 15

Foundational Objectives
- To read, understand and interpret schematic diagrams and other technical drawings.
- To test and evaluate electrical and electronic components.
- To use and interpret meter readings.
- To demonstrate the safe use and knowledge of meters and hand and power tools used in the electrical industry.
- To become knowledgeable of the various principles and characteristics of electricity and electronics.
- To be knowledgeable and skilled with different materials and devices and their application in the electricity and electronics field.

Common Essential Learnings Foundational Objectives
- To understand manual and magnetic starters.
- To connect manual and magnetic starters to different motor circuits. (TL)
- To strengthen students' knowledge of how to measure and calculate numerical data (NUM)

	Learning Objectives	Notes
		MANUAL MOTOR STARTERS
16.1	To examine the purpose of manual motor starters and their size. (COM)	Have students look at several manual starters. Compare the size of a starter with the size of the motor to which it is connected. Connect a manual starter to a motor.
16.2	To describe the overload devices and their location in the motor circuit.	Examine several overload devices and determine how they are connected in a motor circuit.
16.3	To draw a schematic wiring diagram. (COM)	Draw a schematic diagram of a manual starting switch.
16.4	To wire a motor circuit containing a manual starting switch.	Wire a motor circuit using a manual starting switch.
16.5	To wire a single phase motor to be controlled by a manual reversing drum switch.	Connect a motor using a drum switch. Draw a wiring diagram of a motor controlled by a drum switch.
16.6	To wire a three-phase motor. (TL)	Have students draw a wiring diagrams for the following controls and then wire the connections: • three-phase motor controlled by a manual starting switch • three-phase motor controlled by a manual stop-start switch • three-phase motor controlled by a forward-reverse drum switch.

	Learning Objectives	Notes
	MAGNETIC STARTERS	
16.7	To describe the magnetic starter and its advantages. (COM)	Have students disassemble a magnetic starter and label all the parts. Connect a magnetic starter to a motor and observe how it works. Observe how a magnetic starter can be used to reverse a motor.
16.8	To draw an internal wiring diagram of a reversing magnetic starter. (COM)	Have students draw an internal wiring diagram of a reversing magnetic starter. They should use an ohmmeter to measure resistances that will be put on the diagram.
16.9	To describe the operation of thermal overload relays. (COM)	Students should observe how the thermal overloads affect a magnetic starter.
16.10	To calculate the sizes of overload devices required for different electrical motors. (NUM)	Calculate several different sizes of overloads given the motor nameplate information.
16.11	To calculate the wire size and over-current size for a specific motor. (NUM)	Practise several calculations.
	MAGNETIC STARTER CONTROL DEVICES	
16.12	To describe the operation of a momentary contact push button. (COM)	Students should observe and describe how a momentary contact push button switch works.
16.13	To draw schematic symbols of the different types of switches used for control devices. (COM)	Students may draw schematics of various control devices used in motor starters.
16.14	To explain the operation of common control devices used in motor control. (COM)	Students should wire different control devices to a magnetic starter and observe the effects.
16.15	To draw schematic diagrams and symbols used for common control devices. (COM)	Students should practise drawing different circuits using the proper schematic diagram and symbols.

	Learning Objectives	Notes
16.16	To understand the code rules that pertain to control devices and	Review the current federal and provincial resources defining electrical codes and discover the code rules that pertain to the different types of control devices.

switches. (IL, COM)

MAGNETIC CONTROL CIRCUITS

16.17	To connect a three-phase motor to be controlled by a magnetic start.	Wire a 3-pole motor using a schematic diagram.
16.18	To draw a schematic magnetic control circuit that is controlled from two locations by stop-starts. (COM)	Students should observe a motor that is controlled from two locations by stop-start switches and draw a schematic diagram of this magnetic control circuit.
16.19	To connect a three-phase motor controlled from two locations by stop-start switches. (TL)	After the students have drawn the schematic diagram above, they should wire the circuit.
16.20	To draw a schematic control circuit for a magnetic starter operated by a stop-start-jog push button station.	Draw a schematic diagram that uses a magnetic starter controlled by a stop-start-job station.
16.21	To understand electrical interlocks.	Observe a magnetic starter that is controlled by electrical interlocks.
16.22	To connect a magnetic starter controlled by a stop-start-job switch to a three-phase motor. (TL)	Students should wire a three-phase motor to a magnetic starter that is controlled by a stop-start switch.
16.23	To draw a schematic diagram of a magnetic reversing starter to be controlled by a stop-forward-reverse push button switch. (COM, CCT)	Students should observe a magnetic reversing starter controlled by a stop-forward-reverse switch, then develop a schematic diagram for this circuit.
16.24	To connect a magnetic starter controlled by a stop-forward-reverse switch to a three-phase motor. (PSVS)	To wire a three-phase motor to a magnetic starter that is controlled by a stop-forward-reverse switch.
16.25	To draw schematic control circuits that have the proper limiting and safety switches in them. (COM, IL)	Discuss with students the different situations that use motors and magnetic starters (e.g., overhead doors, conveyor systems, fluid levels in tanks). Students should draw a schematic diagram with the proper switching for one or more situations.

Learning Objectives		**Notes**

PROGRAMMABLE LOGIC CONTROLLERS (PLCs)

16.26	To identify the different parts of a programmable controller. (CCT)	Have students examine different parts of a programmable controller (P.C.) and understand the use of each part.
16.27	To understand how a programmable controller	Observe a computer laddering system.

	communicates with itself and the equipment to which it is connected. (NUM)	Explore the binary number system. Refer to *Computer Science 20, 30 Curriculum Guidelines for the Secondary Level, Unit 5.*
16.28	To wire a controller to a motor circuit. (TL)	Determine how timers and counter circuits can be used in a programmable controller. Trouble shoot the circuit using the I/O racks. Wire a motor circuit, with safety devices and controlled by a programmable computer.
16.29	Design a PLC program. (IL)	Design a PLC program with the equipment available.

Module 17A: Introduction to Electronic Components (Core)

Suggested time: 10 - 20 hours **Level:** Introductory
Prerequisites: Modules 2A, 19A

Foundational Objectives

- To use appropriate terminology for electricity or electronics in context.
- To be knowledgeable about the various principles and characteristics of electricity and electronics.
- To test and evaluate the integrity of electrical and electronic components.
- To demonstrate the safe use and knowledge of meters and hand and power tools used in the electrical industry.
- To make and interpret meter readings.

Common Essential Learnings Foundational Objectives

- To understand and apply the basic principles of electronics. (TL, CCT)
- To make various calculations and observations related to electronics. (NUM)
- To use electrical and electronics terminology in context. (COM)

	Learning Objectives	Notes
	RESISTORS	
17.1	Describe wire wound, carbon and metal film resistors. (COM)	Examine the different types of resistors and note how the value of the resistance is indicated on the resistor.
17.2	To observe and explain how colour code and physical size are used in identifying the value of a resistor. (COM, IL)	Decode resistor values using the colour code and physical size.
17.3	To calculate and verify the equivalent resistance of resistors connected in series. (NUM)	With no voltage applied, connect at least two resistors in series. Calculate the equivalent resistance of the series circuit. Measure the equivalent resistance using an ohmmeter.
17.4	To calculate and verify the equivalent resistance of resistors connected in parallel. (NUM)	With no voltage applied, connect at least two resistors in parallel. Calculate the equivalent resistance of the parallel circuit. Measure the equivalent resistance using an ohmmeter.
17.5	To calculate and verify the equivalent resistance of resistors connected in series-parallel. (NUM)	With no voltage applied, connect at least one resistor in series with at least two resistors in parallel. Calculate the equivalent resistance of the series-parallel circuit. Measure the equivalent resistance using an ohmmeter.
	CAPACITORS	
17.6	To draw a schematic symbol for a capacitor. (CCT)	Draw and label the symbols for polarized and non-polarized capacitors. List examples of the types of polarized capacitors.

	Learning Objectives	Notes
17.7	To explain the ratings (capacitance and voltage) of a capacitor. (COM)	Examine the operating characteristics of a capacitor.

17.8	Explain the physical characteristics that determine capacitance. (COM)	Examine different sizes of capacitors. Take a capacitor apart and observe the following: plate area, spacing between plates, type of dielectric.
17.9	To calculate and verify the equivalent capacitance of capacitors connected in series. (NUM)	With no voltage applied, connect at least two capacitors in series. Calculate the equivalent capacitance. Measure the equivalent capacitance using a capacitance meter.
17.10	To calculate and verify the equivalent capacitance of capacitors connected in parallel. (NUM)	With no voltage applied, connect at least two capacitors in parallel. Calculate the equivalent capacitance. Measure the equivalent capacitance using a capacitance meter.
17.11	To calculate and verify the equivalent capacitance of capacitors connected in series-parallel. (NUM)	With no voltage applied, connect at least one capacitor in series with at least two capacitors in parallel. Calculate the equivalent capacitance. Measure the equivalent capacitance using a capacitance meter.

Module 17B: Introduction to Electronics, Diodes (Optional)

Suggested time: 5 - 8 hours **Level:** Intermediate
Prerequisites: Modules 2A,17A

	Learning Objectives	Notes
		SEMI-CONDUCTOR DIODES
17.12	Draw the symbol for a diode. (COM)	Draw and explain the parts of a diode. Explain polarity and the direction of electron flow through a diode.
17.13	To identify different diodes and determine the ratings.	Examine a diode and identify the anode and cathode. Use a cross-reference manual to determine the operating characteristics of the diode.
17.14	To meter test a diode. (TL)	Test a diode using an ohmmeter. Test a diode using a multimeter set to the “diode test” position. Explain the difference between the junction resistance reading shown on the ohmmeter with the junction breakdown voltage shown on the multimeter. List precautions necessary when using a meter to check a diode.
17.15	Describe the basic function of a diode. (COM))	Connect a diode in a low voltage DC circuit including an output device such as a lamp and observe the effect of changing the direction of orientation of the diode. Connect a diode in a low voltage AC circuit including an output device such as a lamp and observe the effect of changing the direction of orientation of the diode.
17.16	Explain the rating and limitations of a diode.	Interpret data sheets to explain where different types of diodes could be used.

Module 17C: Introduction to Electronics, Rectifiers (Core for Electronics)

Suggested time: 5 - 8 hours
Level: Intermediate
Prerequisites: Modules 2A, 17B

	Learning Objectives	Notes
17.17	To describe the conditions required to turn on or turn off a Silicon Controlled Rectifier (SCR).	Have students set up a circuit using an SCR.
17.18	To list two applications of the SCR.	Identify the SCR in a schematic diagram and determine how it is used in the circuit.

Module 17D: Introduction to Electronics, Rectifier Circuits (Core for Electronics)

Suggested time: 5 - 10 hours
Level: Advanced
Prerequisites: Modules 2A, 17C

	Learning Objectives	Notes
17.19	To explain the operation of a half - wave rectifier. (COM)	Wire a diode into a circuit to give half-wave rectification. With the help of a meter, determine output voltages (multimeter, oscilloscope). Draw a schematic circuit of the half-wave rectifier circuit.
17.20	To explain the operation of a full-wave rectifier. (COM)	Draw a schematic diagram of a full-wave rectifier circuit. Wire a full-wave rectifier circuit. With the help of a multimeter and oscilloscope determine output voltages.
17.21	To describe the effect of a capacitor on the output of a power supply.	Wire a capacitor into a rectifier circuit to give elementary filtering.

Module 18A: Cells and Small Voltage Sources (Core)

Suggested time: 10 - 15 hours **Level:** Introductory
Prerequisite: Module 2

Foundational Objectives
- To test and evaluate the integrity of electrical and electronic components.
- To design and/or build circuits to an acceptable standard capable of producing a desired output.
- To be knowledgeable of the various principles and characteristics of electricity and electronics.
- To demonstrate the safe use and knowledge of meters and hand and power tools used in the electrical industry.

Common Essential Learnings Foundational Objectives
- To understand and describe the general characteristics of commonly used dry cells. (COM)
- To compare various kinds of batteries. (CCT)
- To make calculations related to cells and voltage. (NUM)

	Learning Objectives	Notes
		BATTERIES
18.1	To describe the basic operation of a primary cell. (COM)	Examine and describe how a primary cell is constructed. Compare and contrast different types of batteries (e.g., carbon-zinc, alkaline, mercury).
18.2	To explain how cells are rated.	Study and compare battery voltage output, energy capacity and shelf life.
18.3	To define direct current.	Examine an output voltage of a DC source through an oscilloscope.
18.4	To determine output voltages of batteries connected in parallel, series and series parallel. (NUM)	Connect batteries in series and determine output voltage. Connect batteries in parallel and determine output voltage. Design battery configuration with predetermined values.
18.5	To explain how batteries and cells can be checked. (COM)	Test batteries and cells to determine if they are any good. Practise safe work procedures when testing batteries.
18.6	To examine the common types of rechargeable cells.	Examine different types of rechargeable cells and compare them with primary cells.

Module 18B: Cells and Small Voltage Sources (Core)

Suggested time: 5 - 10 hours
Prerequisites: Modules 2, 18A

Level: Intermediate

	Learning Objectives	Notes
18.7	List small voltage sources of electricity. (CCT)	Examine different types of energy sources (light energy, chemical energy, heat energy, piezoelectric effect, friction, mechanical-magnetic) and explain how electrical energy is produced. Connect a solar cell to a circuit and use a light source to produce electron flow. Using two different metals (copper and zinc are good) and an orange, connect a sensitive ammeter such as a galvanometer to the metal pieces inserted in two slits in the orange and observe the effect of the movement of electrons from one metal piece to the other. Connect a thermocouple to a sensitive ammeter and observe the effect of heating the thermocouple. Connect a piezoelectric device such as a phonograph pick up cartridge to a small amplifier and note the effect of touching the needle attached to the cartridge. Produce an electric charge on an ebonite or plastic rod by rubbing it with some fur and notice the effect on small pieces of paper as the rod is brought into their vicinity. Using a permanent magnet, a coil of wire and a sensitive ammeter, preferably a meter with a zero centering needle, observe the effect of moving the magnet in the coil. Note the direction of needle movement as the magnet is moved into and out of the coil.
18.8	To examine various methods of producing electrical energy. (IL)	Examine electrical devices such as microphones, oven thermometers, bicycle generators, solar powered calculators and portable radios. Describe the method used for producing electron flow in each of the devices.

Module 19A: Measuring Instruments, Meters (Core)

Suggested time: 5 - 10 hours **Level:** Introductory
Prerequisites: Modules 1, 2

Foundational Objectives
- To work safely and cooperatively with other students and handle materials in a safe manner.
- To demonstrate the safe use and knowledge of meters and hand and power tools used in the industry.
- To make and interpret meter readings.
- To use appropriate terminology for electricity or electronics in context.

Common Essential Learnings Foundational Objectives
- To understand meters used in AC and DC circuits. (COM)
- To compare different kinds of meters. (CCT)
- To strengthen knowledge by measuring with meters and manipulating and interpreting data. (NUM)

	Learning Objectives	Notes
19.1	To be able to connect basic meters to an electrical circuit.	Students should connect a voltmeter to a given circuit and be able to read it correctly. Repeat with an ammeter and an ohmmeter. **Be aware of the safety concerns when hooking a meter to a live circuit.** Students should examine a variety of meters and determine how they function internally. Show students how to change a galvanometer to an ammeter.
19.2	To be able to read an analog meter correctly. (NUM)	Connect several analog meters to different circuits and have students read the outcome. Change the range switch on an analog meter and have students determine the reading.
19.3	To use a multimeter correctly. (PSVS)	Explore, list and describe all the uses of a multimeter and determine how to connect it to an electrical circuit (voltage, current, resistor). Review and practise safety precautions when handling, using and storing a multimeter.
19.4	To compare an analog and digital meter. (CCT)	Use both types of meters and determine some advantages and disadvantages of each. Students should be able to describe D'Arsonval meter movement.
19.5	To be able to read different types of electrical service meters.	Students can read and calculate energy costs from a kilowatt-hour meter on their house or in the school.

Module 19B: Measuring Instruments, Meters (Core)

Suggested time: 4 - 7 hours **Level:** Intermediate
Prerequisites: Modules 1, 2, 19A

Review or repeat Module 19A, as required before progressing to the next level module.

	Learning Objectives	Notes
		OSCILLOSCOPE
19.6	To explain the function of each of the controls on the oscilloscope. (COM)	Read the manual for the oscilloscope and locate the controls on the instrument. Observe the different functions of each of the controls on the oscilloscope.
19.7	To measure voltage using an oscilloscope. (NUM)	Connect an oscilloscope to a voltage supply (AC and DC) and determine different voltages.
19.8	To interpret wave forms on an oscilloscope. (TL)	Observe the different wave forms on an oscilloscope.
19.9	To use the oscilloscope to measure phase shift and frequency using Lissajous patterns. (NUM)	Connect the oscilloscope to a simple circuit made up of a capacitor and resistor connected to a sine wave source and measure the phase shift across the capacitor. Using the appropriate inputs of the oscilloscope, connect the probes to the "known" and "unknown" frequency sources and, using the Lissajous pattern, determine the frequency of the unknown wave.
19.10	To understand how pulse measurements are made on an oscilloscope. (COM)	Connect the oscilloscope to a digital circuit (e.g., 7490 decade counter) and measure: pulse width (PW), duty cycle (DC), rise time, fall time, amplitude, average value, pulse recurrence time (PRT) and pulse recurrence frequency (PRF).
		LOGIC PROBE
19.11	To explain the use of the logic probe. (COM)	Touch the logic probe to various points on a digital circuit and interpret high and low logic levels.
19.12	To test digital components using the logic probe. (TL)	Use the logic probe to test a digital circuit that has been altered by the instructor.

Module 20: Careers (Core)

Students following the Electronics course can omit the objectives 20.1, 20.2

Suggested time: 2 - 5 hours **Level:** Introductory
Prerequisite: None

Foundational Objectives

- The student will develop an awareness of some of the career opportunities in the electrical and electronics industry.
- To provide students with experience in the electrical and electronics industry that will enable them to make an informed decision about a career decision.

Common Essential Learnings Foundational Objectives

- To develop students' abilities to access knowledge. (IL)
- To promote both intuitive, imaginative thought and the ability to evaluate ideas, processes, experiences and objects in meaningful contexts. (CCT)

	Learning Objectives	Notes
20.1	To explore apprenticeship and designated trades.	Students should understand apprenticeship. Generate a list with students, of apprenticeship trades and a definition of apprenticeship. Outline the advantages and disadvantages of pursuing a career through apprenticeship. Refer to resource list for further information on apprenticeship opportunities.
20.2	To explore how the secondary level curriculum articulates with Level I of apprenticeship. (COM)	Show students the training plan. Explain how completing all the objectives and covering the appropriate modules can prepare them to challenge the Level I trade exam.
20.3	To generate a list of career opportunities related to the electrical trade or electronics service industry. (COM)	Students will create a list of different career opportunities. Encourage students to use a variety of source for information: guidance counsellors, career software packages, personal interviews, government resources, websites, etc.
20.4	To identify personal skills and interests that may lead to career exploration in the electricity, electronics trades. (CCT)	Ask students to create an inventory of their activities and interests. Have students examine their list to determine how these activities may be undertaken using a variety of computer software packages. (IL) Once students have determined an area of interest, research on careers can be done using available resources in the library, community and Internet.
20.5	To determine skills and interests that enhance career choices. (CCT)	From the list created, ask the students to select two choices of possible occupations for further research. Investigate the occupational choices including: • description of work duties • what personal qualities individuals should possess • process to become certified within the trade/occupation or career • length of education and training • school locations

- cost of education and upgrading
- trends within the business or career
- the best and worst parts of the job
- beginning salary
- opportunities for advancement.

If a student engages in work study, he or she may investigate career links within the community for possible work study placements. The student may conduct an interview of the professional/tradesperson as part of his or her experience.

Refer to Appendix D, Career Research Interview Questions.

Module 21A: Introductory Printed Circuit Board Fabrication (Optional)

Suggested time: 5 - 10 hours **Level:** Introductory
Prerequisites: Modules 2, 17A

Foundational Objectives
- To use appropriate terminology for electricity or electronics in context.
- To design and/or build circuits to an acceptable standard capable of producing a desired output.
- To demonstrate the safe use and knowledge of meters and hand and power tools used in the electrical industry.

Common Essential Learnings Foundational Objectives
- To strengthen knowledge and understanding of how to compute, measure, estimate and interpret numerical data and when to apply these skills and techniques. (COM)
- To explore the technical, implications of present technology and of impending technological developments within the field of electronics. (TL)

	Learning Objectives	Notes
		PERMANENT INK METHOD
21.1	To select an appropriate size of copper clad and prepare the surface for the circuit pattern. (TL)	Obtain a piece of copper clad material and cut it to a size appropriate for the circuit being constructed.
21.2	To draw the pattern using waterproof material. (COM)	Use permanent ink, fingernail polish, lacquer or waterproof liquid paper correction fluid to draw the circuit pattern.
21.3	To etch the board in an etchant used for removing the copper.	Etchants used could be either ferric chloride or ammonium persulphate.
21.4	To drill holes to receive component leads.	Drill the holes using dental bits in a drill press or other hand-held motorized tool.
		PASTE AND CUT METHODS
21.5	To select an appropriate size of copper clad material and prepare the surface for the circuit pattern. (CCT)	Obtain a piece of copper clad material.
21.6	To cover the surface of material with a film such as masking tape or commercial plastic adhesive.	Show the advantages of using different film covers. A good choice would be a clear material with an adhesive backing that can be applied directly to the copper clad material.
21.7	To draw a pattern on the film or obtain a photocopy of a pattern.	Have students draw their own pattern or photocopy a pattern and glue it to the film.
21.8	To cut out and remove the sections of the pattern that are to be etched.	Use an Exacto knife or other sharp knife to cut and remove the unwanted sections of the film from the copper clad material.

	Learning Objectives	Notes
21.9	To etch the board in an etchant	Etchants used could be either ferric chloride or ammonium persulphate.

used for removing copper.

21.10	To drill holes to receive component leads.	Drill the holes using dental or other small bits in a drill press or other hand-held motorized tool.

Module 21B: Advanced Printed Circuit Board Fabrication (Optional)

Suggested time: 8 - 10 hours **Level:** Intermediate
Prerequisites: Modules 1, 2, 17A, 21A

	Learning Objectives	Notes
		PHOTOGRAPHIC METHOD
21.11	To select an appropriate size of copper clad material and prepare the surface for the pattern for the circuits. (TL)	Obtain a piece of copper clad material.
21.12	To cover correctly an unsensitized board with photosensitive material with appropriate chemistry. (CCT)	The application of either positive or negative chemistry, depending on whether a positive or negative tracing image is desired, may be sprayed or painted on in subdued light. Avoid exposure to ultra-violet light. Note: If sensitized board is used, follow appropriate instructions.
21.13	To demonstrate the correct method of exposure and development of a properly prepared board.	Contact print the image on the sensitized surface and develop in appropriate chemistry. The development step must be accomplished without additional exposure to ultra-violet light.
21.14	To etch the board in an etchant used for removing copper.	Etchants used could be either ferric chloride or ammonium persulphate.
21.15	To drill holes to receive component leads.	Drill the holes using dental or other small bits in a drill press or other hand-held motorized tool.
		SILK SCREEN METHOD
21.16	To select an appropriate size of copper clad material and prepare the surface for the pattern. (CCT)	Have students choose from a selection of precut pieces or have them cut their own piece to size.
21.17	To use a prepared silk screen to print the desired pattern on the copper clad surface. (TL)	If facilities exist, the students could produce their own silkscreen pattern to the copper clad material.
21.18	To demonstrate how to etch the board in an etchant used for removing the copper from the exposed area. (IL)	Etchants used could be either ferric chloride or ammonium persulphate.
21.19	To drill holes to receive component leads.	Drill the holes using dental or other small bits in a drill press or other hand-held motorized tool.

Module 22A: Soldering, De-soldering and Recycling Components (Optional)

Suggested time: 5 - 10 hours **Level:** Introductory
Prerequisite: Module 2A

Foundational Objectives
- To read and interpret schematic diagrams and other technical documents.
- To use appropriate terminology for electricity or electronics in context.
- To work safely and cooperatively with other students and handle materials in a safe manner.
- To demonstrate the safe use and knowledge of meters and hand and power tools used in the electrical industry.

Common Essential Learnings Foundational Objectives
- To promote both intuitive, imaginative thought and the ability to evaluate ideas and processes, in order to find meaningful solutions to problems. (CCT)
- To explore the technical, social and cultural implications of present technology and of impending technological developments as they arise within electronics. (TL)

	Learning Objectives	Notes
	IDENTIFYING AND DE-SOLDERING	
22.1	To identify re-useable components on a circuit board and select various items for reuse. (TL)	Disassemble discarded electronic devices with the intent to recycle the parts.
22.2	To demonstrate the correct method for de-soldering electronic components. (IL)	The salvaged parts must be checked for accuracy if they are to be reused. This exercise may be most valuable to teach soldering and de-soldering techniques. Students may use de-soldering bulbs, solder suckers and wicks in the process.
	TESTING AND SORTING	
22.3	To demonstrate the procedure to test each component using proper techniques. (TL)	Refer to Module 19 for information about the use of meters.
22.4	To demonstrate ability to differentiate between similar components and store appropriately. (CCT)	Plastic containers or egg cartons may be used to store the parts as they are sorted.
	SOLDER AND SOLDERING	
22.5	To describe the content of solderand explain why 63/37 is the best solder for use in electronics. (COM)	Research different tin/lead compositions and list some characteristics of each type. Review safety considerations regarding chemicals given off while soldering as well as the heat generated by the soldering tools.

| | Learning Objectives | Notes |

22.6	To list the advantages and disadvantages of using a soldering iron or soldering gun in the soldering application. (CCT)	List the ratings of the soldering irons and soldering guns on hand and describe the application of each type.
22.7	To describe the function and use of flux in the soldering process. (COM)	Solder a connection with and without the use of flux and describe the difference in performance of the solder.
22.8	To practise making a reliable soldered connection on a printed circuit board.	Have students solder connections on their projects or solder their recycled parts on a surplus circuit board.
22.9	To solder surface mount technology (SMT) devices on a circuit board and check the results of the soldering operation.	Follow the correct procedure for SMT devices.

Module 22B: Soldering, De-soldering and Recycling Components (Optional)

Suggested time: 5 - 10 hours
Level: Intermediate
Prerequisite: Module 22A

Review or repeat Module 22A as required.

Module 23A: Power Supplies (Core)

Suggested time: 10 - 15 hours **Level:** Intermediate
Prerequisites: Modules 1, 2, 17A

Foundational Objectives

- To work safely and cooperatively with other students and handle materials in a safe manner.
- To be knowledgeable and skilled with different materials and devices and their application in the electricity and electronics field.
- To demonstrate the safe use and knowledge of meters and hand and power tools used in the electrical industry.
- To make and interpret meter readings.
- To test and evaluate the integrity of electrical and electronic components.

Common Essential Learnings Foundational Objectives

- To use the appropriate vocabulary and symbols related to power supply. (COM)
- To make necessary calculations and decisions related to power supply. (NUM, IL)
- To develop an understanding of the limitations of technology (TL).
- To use problem-solving strategies to troubleshoot power supplies. (CCT)

	Learning Objectives	Notes
		TRANSFORMERS
23.1	To select a suitable transformer for the required power supply. (CCT)	Using the information acquired in Module 14, determine the type of transformer required for the application. Select and test the transformer if it is being recycled from salvaged parts.
		RECTIFICATION
23.2	To explain the operation of a half-wave rectifier. (COM)	Connect a diode into a circuit to provide half-wave rectification. Using a multimeter measure the output voltage. Observe the shape of the output wave using an oscilloscope. Draw the schematic diagram of a half-wave rectifier circuit.
23.3	To troubleshoot a half-wave rectifier. (CCT)	No power applied – use a multimeter to check the diode and transformer. Analyze and predict the expected results of: a) a shorted transformer b) an open transformer c) a shorted diode d) an open diode.

	Learning Objectives	Notes
23.4	To explain the operation of a full-wave rectifier. (COM)	Connect two diodes and a center-tap transformer into a configuration that will provide full-wave rectification. Using a multimeter, measure the output voltage. Observe the shape of the output wave using an oscilloscope. Draw the schematic diagram of a full-wave rectifier circuit. Analyze and predict the expected results of: a) a shorted transformer b) an open transformer c) a shorted diode or diodes b) an open diode or diodes.
23.5	Troubleshoot a full-wave rectifier. (CCT, TL)	Connect four diodes in a bridge rectifier configuration to a transformer to provide full-wave rectification. Using a multimeter, measure the output voltage.
23.6	To explain the operation of a bridge rectifier. (COM)	Observe the shape of the output wave using an oscilloscope. Draw the schematic diagram of the bridge rectifier circuit taking special note of the orientation of the diodes.
23.7	Troubleshoot a bridge rectifier. (CCT, TL)	Analyze and predict the expected results of: a) a shorted transformer b) an open transformer c) a shorted diode or diodes d) an open diode or diodes.

Module 23B: Power Supplies (Core)

Suggested time: 10 – 15 hours **Level:** Intermediate
Prerequisite: Module 23A

	Learning Objectives	Notes
	FILTERING	
23.8	To explain how capacitors are used in filter circuits. (TL, CCT)	Properly connect a filter capacitor to the output of an unfiltered power supply. Using an oscilloscope, observe the wave-form before and after the capacitor. Measure the voltage before and after the capacitor and note the effect on the output voltage of the power supply.
23.9	Explain the pi-filter configuration. (CCT, COM)	Properly connect two capacitors and a resistor to the output of an unregulated power supply in the configuration of a pi-filter. Using an oscilloscope, observe the wave-form before and after the pi-filter. Measure the voltage before and after the pi-filter and note the effect on the output voltage of the power supply. Replace the resistor in the above configuration with an inductor and note any change in the filtered wave-form.
23.10	To troubleshoot a defective filter. (CCT, COM)	Taking special precautions in the application and disconnection of the power source and with the use of instruments (multimeter and oscilloscope), observe the output of a power supply with a defective filter. Analyze and predict the expected results of: a) a shorted filter capacitor b) an open capacitor.
23.11	To explain and express ripple in terms of percent. (CCT, COM)	Using an oscilloscope measure the ripple of the output of a filtered power supply and calculate the percent ripple.
	VOLTAGE REGULATION	
23.12	To describe the action of the bleeder resistor. (IL, COM)	Analyze the schematic diagram of a power supply and explain the purpose of the bleeder resistor.
23.13	To calculate the value of a bleeder resistor. (NUM)	Calculate the value of the bleeder resistor from a given set of requirements for the power supply.
23.14	To design a simple zener diode voltage regulator. (COM, CCT)	Draw the schematic of a zener diode regulated power supply. Connect the circuit and verify the regulation of the output voltage as the input voltage is varied.
23.15	To explain the operation of a transistor regulated power supply. (CCT, COM)	Construct and analyze a circuit using a transistor and zener diode for voltage regulation.

| | Learning Objectives | Notes |

23.16	To design a simple series feedback regulator using an operational amplifier (op-amp). (COM, CCT)	Construct and analyze the regulation of a power supply using an operational amplifier (op-amp).

Module 23C: Power Supplies (Core)

Suggested time: 10 - 15 hours **Level:** Advanced
Prerequisites: Modules 1, 2, 17A, 23A, 23B

	Learning Objectives	Notes
	FUSES and OVER-CURRENT DEVICES	
	Refer to Module 7 for additional information	
23.17	Explain the three ratings given to fuses. (COM)	Describe the ratings of a sample of fuses.
23.18	Describe the opening characteristics of a fast-blow, medium-blow and slow-blow fuse. (COM)	Using reference manuals, find the ratings for the samples in 23.17.
23.19	To identify fuses of different styles.	Associate samples of fuses with the styles available.
23.20	To select the most appropriate fuse for a given application. (CCT, IL)	Select the proper type of fuse given a set of required characteristics.
23.21	To explain the suitability of using either fuses or circuit breakers. (CCT)	List the characteristics of fuses and circuit breakers and give examples of the appropriate use of each.
23.22	To identify two types of circuit breakers. (COM, IL)	List characteristics of each type of breaker.
23.23	To describe a fuse resistor and give an application. (CCT)	Locate the fuse resistor in a schematic diagram and explain its use.
23.24	To describe how temperature affects a thermistor. (CCT)	Connect a circuit using a thermistor and measure the effect of temperature rise.
23.25	To describe how voltage affects a varistor. (CCT)	Connect a circuit using a varistor and measure the effect of change in voltage.

Module 24A: Basic Transistor Theory (Core)

Suggested time: 15 - 20 hours **Level:** Intermediate
Prerequisites: Modules 1, 2, 17A, 17B

Foundational Objectives
- To read and interpret schematic diagrams and other technical documents.
- To use appropriate terminology for electricity or electronics in context.
- To analyze circuits and predict their output.
- To become knowledgeable of the various principles and characteristics of electricity and electronics.
- To design and/or build circuits to an acceptable standard capable of producing a desired output.
- To demonstrate the safe use and knowledge of meters and hand and power tools used in the electrical industry.
- To make and interpret meter readings.
- To test and evaluate the integrity of electrical and electronic components.

Common Essential Learnings Foundational Objectives
- To develop knowledge of the principles of basic transistor theory. (COM)
- To develop an understanding of how transistor theory is measured and evaluated. (CCT)
- To use instruments to assess transistor circuits. (TL)
- To develop a responsible attitude to safety. (PSVS)

Note: Other CELs may be emphasized.

	Learning Objectives	Notes
		P-N JUNCTION
24.1	Describe P-type and N-type material.	Draw diagrams of the pure silicon and germanium atoms. Draw diagrams of the silicon or germanium material doped with indium, gallium and boron (producing P-type material). Draw diagrams of the silicon or germanium material doped with arsenic, phosphorus, bismuth and antimony (producing N-type material).
24.2	Define depletion region. (COM)	Explain what happens when the two types of material form a junction.
24.3	Explain the action of the P-N junction. (COM)	Draw a diagram showing the effect of applying different polarities on the junction.
24.4	Name and explain two diode ratings. (COM)	Locate different types of diodes in a cross reference manual.
24.5	Identify the cathode and the anode.	Test several different shaped diodes to determine the cathode and anode.
24.6	To test a diode using both an ohmmeter and a multimeter and noting the importance of the different readings obtained on each meter.	Use an ohmmeter and a multimeter to test diodes and check the labeling of the leads.

	Learning Objectives	Notes

24.7	Draw the symbols for a diode, zener diode and varactor diode. (COM)	Locate these symbols.
24.8	State the characteristics of a zener diode. (COM)	Locate the characteristics and draw a graph showing current vs. inverse voltage.
24.9	State the characteristics of a varactor diode. (COM)	Locate the characteristics and explain.

SILICON CONTROLLED RECTIFIERS (SCR)

24.10	To describe the conditions required to turn a silicon controlled rectifier SCR on and off. (COM)	Set up a circuit using an SCR and test the operation by turning it on and off. Test the SCR and identify the leads.
24.11	To list two application of the SCR.	Examine circuits and determine the use of the SCR. Explain the operation of the SCR.

TYPES OF TRANSISTORS

24.12	Describe the structure of a transistor. (COM)	Have students differentiate bi-polar junction transistors (BJT) and field efficient transistors. Have the students identify the N material and the P materials needed to create a transistor. Refer to 24.1 to 24.4.
24.13	Draw and label a pictorial diagram of an NPN transistor.	Use a cross-reference manual and sample transistor to draw the diagram.
24.14	Draw and label a schematic symbol of an NPN transistor. (COM, CCT)	Choose from a list of diagrams to draw and label.
24.15	Draw and label a pictorial diagram of a PNP transistor. (COM)	Use a cross-reference manual and sample transistor to draw the diagram.
24.16	Draw and label a schematic symbol of a PNP transistor. (COM)	

Module 24B: Transistor Theory (Core)

Suggested time: 15 - 20 hours **Level:** Advanced
Prerequisite: Module 24A

Learning Objectives	Notes

TRANSISTOR AMPLIFIER CONFIGURATIONS

24.17	To draw a schematic diagram showing correct biasing (polarity and voltage level) of an NPN and PNP transistor in a simple common-emitter circuit configuration.	Set up the circuit for the common-emitter circuit and draw the schematic.
24.18	Explain how a small change in base voltage causes a large change in collector voltage-emitter circuit configuration. (CCT)	Using an oscilloscope, measure the input and output voltages in the circuit set up in 24.17. Calculate the voltage gain of the circuit.
24.19	Troubleshoot the common-emitter amplifier. (CCT)	Using appropriate instruments, troubleshoot a common-emitter amplifier circuit that has been altered by the instructor.
24.20	To draw a schematic diagram showing correct biasing (polarity and voltage level) of an NPN and a PNP transistor in a simple common-collector circuit configuration.	Set up the circuit for the common-collector circuit and draw the schematic diagram.
24.21	Explain how a small change in base voltage causes a large change in collector voltage in a common-collector configuration.	Using an oscilloscope, measure the input and output voltages in the circuit set up in 24.19. Calculate the voltage gain of the circuit. Compare the voltage gain of the common-collector amplifier with the gain of the common-emitter amplifier.
24.22	To troubleshoot the common-collector amplifier.	Using appropriate instruments, troubleshoot a common-collector amplifier circuit that has been altered by the instructor.
24.23	To draw a schematic diagram showing correct biasing (polarity and voltage level) of an NPN and a PNP transistor in a simple common-base circuit configuration.	Set up the circuit for the common-base circuit and draw the schematic diagram.

	Learning Objectives	Notes
24.24	Explain how a small change in emitter voltage causes a large change in collector voltage in a common-base configuration. (CCT)	Using an oscilloscope, measure the input and output voltages in the circuit set-up in 24.23. Calculate the voltage gain of the circuit. Compare the voltage gain of the common-base amplifier with the gain of the common-emitter amplifier and the common-collector amplifier.
24.25	To troubleshoot the common-base amplifier.	Using appropriate instruments, troubleshoot a common-base amplifier circuit that has been altered by the instructor.
24.26	To evaluate each of the above transistor amplifier configurations. (CCT)	Compare the characteristics of each of the amplifiers and describe suitable applications and uses of each configuration.
		COUPLING NETWORKS
24.27	To recognize direct coupled stages. (COM, CCT, IL)	Have students select from a set of schematics, circuits that use direct coupling for connecting the output of one stage to the input of the next stage. Give examples of the appropriate use of such coupling. List advantages and disadvantages of using direct coupling.
24.28	To recognize and locate in a circuit the components used in resistive-capacitive (RC) coupling. (COM)	Locate the components in a circuit incorporating resistive-capacitive components (RC) coupling. Test the components. Give examples of the use of RC coupling. List and explain the limitations of using RC coupling.
24.29	To recognize the application of impedance coupling.	Locate the components in a circuit where impedance coupling is used. Compare the configuration to RC coupling. Explain the use and application of impedance coupling.
24.30	To recognize the use of transformer coupling for connecting two stages.	Locate the transformer used for coupling the stages. Describe appropriate uses of transformer coupling. Explain maximum power transfer between stages and how this is attained using transformer coupling. Relate the type of core used in the transformer to the frequency application.

Module 24C: Transistor Theory (Core)

Suggested time: 15 - 20 hours **Level:** Advanced
Prerequisite: Module 24B

	Learning Objectives	Notes
	JUNCTION FIELD EFFECT TRANSISTORS (JFET)	
24.31	Describe the operation of the junction FET. (COM)	Set up a circuit using a junction FET and observe and describe the action of the circuit.
24.32	Draw a schematic diagram of a properly biased N-channel and P-channel JFET. (IL)	Set up one of the circuits and draw the schematic diagram.
	INSULATED GATE FIELD EFFECT TRANSISTORS (IGFET)	
24.33	Describe the operation of the IGFET.	Set up a circuit and observe the operation.
24.34	List the safety precautions to be used when handling and using an IGFET. (PSVS)	Read the label on the containers regarding the shipping and handling of sensitive devices.
	OPERATIONAL AMPLIFIERS	
24.35	To describe the basic operation of the op-amp (non-inverting mode). (COM)	Construct a circuit using an op-amp as a voltage amplifier in non-inverting mode. Measure the input voltage and output voltage. Calculate the gain. Describe the results of the amplification.
24.36	To describe the operation of the op-amp (inverting mode).	Construct a circuit using an op-amp as a voltage amplifier in inverting mode. Measure the input and output voltage. Calculate the gain.
24.37	To use the op-amp as a voltage comparator. (TL)	Construct the circuit of an op-amp voltage comparator and test the operation. Adjust the feedback resistor and note the effect on the output.
24.38	To use the op-amp as a timer.	Construct a circuit using an op-amp as a timer and explain the action of the circuit.
24.39	To explain the use of the op-amp in voltage regulation (see Module 23.25).	Connect an op-amp to an unregulated power supply and explain the action of the op-amp.
24.40	To describe the characteristics of the low-pass, high-pass and band-pass active filters.	Construct the circuits for each of the filters using op-amps. Observe the waveform and plot response curves using an oscilloscope. Explain the action of the op-amps.

Module 25: Integrated Circuits (Optional)

Suggested time: 3 - 5 hours **Level:** Advanced
Prerequisite: Module 24

Foundational Objectives
- To use appropriate terminology for electricity or electronics in context.
- To test and evaluate the integrity of electrical and electronic components.

Common Essential Learnings Foundational Objectives
- To use the vocabulary and symbols related to junction FET and the insulated gate FET. (COM)

	Learning Objectives	Notes
	INTEGRATED CIRCUITS	
25.1	To list two advantages and two disadvantages of using integrated circuits over conventional circuits.	Compare the schematic diagrams of an integrated circuit and the equivalent circuit made up of discreet components.
25.2	To describe the difference between SSI (small scale integration), MSI (medium scale integration), LSI (large scale integration) and VLSI (very large scale integrated) circuits. (COM)	Compare the schematic diagrams of each of the four types of integrated circuits.
25.3	To describe two integrated circuit (IC) packages.	Handle a selection of integrated circuits in different packages.
25.4	To determine the specific application of a given integrated circuit. (CCT)	Use data sheets and cross-reference manuals to determine the use of the integrated circuit.
25.5	To associate the use of an integrated circuit with the equivalent circuit created from discreet components. (CCT)	Examine operating circuits and then identify applications for the use of integrated circuits with power output, voltage regulation and signal processing.

Module 26A: Tuned Circuits and Oscillators (Core)

Suggested time: 15 - 20 hours **Level:** Intermediate
Prerequisite: Module 25

Foundational Objectives

- To read and interpret schematic diagrams and other technical documents.
- To use appropriate terminology for electricity or electronics in context.
- To become knowledgeable about the various principles and characteristics of electricity and electronics.
- To analyze circuits and predict their output.

Common Essential Learnings Foundational Objectives

- Discuss how components such as capacitors and inductors react to AC.
- To strengthen students' knowledge and understanding of how to compute, measure, estimate and interpret numerical data, and when to apply these skills and techniques, and why these processes apply within the particular framework of electronics. (NUM)
- To develop students' abilities to see comparisons within electronics and give reasons for their positions. (CCT)
- To develop students' skills and abilities to identify their learning needs. (IL)
- To enable students to understand and use the vocabulary, structures and forms of expression. (COM)

	Learning Objectives	Notes
	CAPACITORS	
26.1	To describe the charging and discharging process in a capacitor. (COM)	Set up a circuit then measure the length of time required for a capacitor to charge and discharge.
26.2	To calculate the capacitive reactance of a circuit. (CCT, NUM)	Provide the students with a schematic diagram of a circuit showing capacitor values and frequency.
26.3	To explain the phase relationship between voltage and current in both a series and parallel resistive-capacitive (RC) circuit. (NUM)	Introduce students to the concept of phase relationships through the use of vector diagrams.
26.4	To define and calculate the "time constant". (COM, NUM)	Set up an RC circuit and calculate and verify the "time constant".
26.5	To list four applications of time constants. (CCT)	Study several schematics diagram and determine the use of the RC network.

	Learning Objectives	Notes
	INDUCTORS	
26.6	To explain how an inductor operates and the factors affecting inductance. (COM, CCT)	Provide students with information regarding the characteristics of an inductor.
26.7	To calculate the total inductance of series connected inductors. (NUM)	In order to do the calculations, provide the students with a schematic diagram showing values.
26.8	To calculate the total inductance of parallel connected inductors.	Provide a schematic diagram showing values.
26.9	To calculate the inductive reactance of a circuit.	Provide the students with a schematic diagram showing inductor values and frequency.
26.10	To compare the phase angle between voltage and current in an inductor.	Compare the phase angle of an inductor to the phase angle of a capacitor.
26.11	To list two applications for simple resistive-inductive (RI) circuits.	Provide schematic diagrams showing RI networks and describe the action.

Module 26B: Tuned Circuits and Oscillators (Core)

Suggested time: 15 - 20 hours **Level:** Advanced
Prerequisite: Module 26A

	Learning Objectives	Notes
		IMPEDANCE AND RESONANCE
26.12	To calculate the impedance, current or voltage of a circuit. (NUM)	Provide students with a schematic diagram showing all but the required parameters.
26.13	To calculate the phase angle in both a series and parallel circuit. (NUM)	Provide a schematic diagram showing all required parameters.
26.14	To define resonance. (COM)	Indicate through the use of a vector diagram, the concept of resonance.
26.15	To calculate the resonant frequency of a network. (NUM)	Provide the students with a schematic diagram showing the value for the inductor and capacitor.
26.16	To calculate the value of the capacitor required for resonance.	Provide a schematic diagram with the value of the inductor.
26.17	To calculate the value of the inductor required for resonance. (CCT, NUM)	Provide a schematic diagram with the value of the capacitor.
26.18	To list the characteristics of a series resonant circuit. (COM, IL)	Have students set up a circuit and observe the effect on current and voltage as the circuit approaches resonance.
26.19	List the characteristics of a parallel resonant circuit. (COM)	Have students set up a parallel resonant circuit. Describe the effect of voltage and current as the frequency approaches resonance.
26.20	Define bandwidth and explain the factors affecting bandwidth.	Have students list the factors that affect bandwidth and sketch a graph showing bandwidth on a resonance curve.
26.21	Define “Q” in terms of the ability of the circuit to discriminate between frequencies.	Explain the concept of “Q” in a resonant circuit. Give examples of the effect of different values. Provide a schematic diagram showing all required parameters.
26.22	To calculate the bandwidth of a circuit.	Provide a schematic diagram showing all required parameters.
26.23	To draw a typical resonance curve for both a series and parallel circuit. (COM)	Have students draw a schematic diagram showing all required parameters.

	Learning Objectives	Notes
26.24	To draw the circuit and explain the action of band-pass, band-stop, low-pass and high-pass filter networks. (CCT)	Provide students with the description of each filter and its circuit application.
		OSCILLATORS
26.25	To describe the conditions required for oscillation to occur. (COM)	Research and list the factors that enable oscillation.
26.26	To identify LC Oscillators. (CCT)	These inductive capacitive circuits are often called tank circuits or flywheel circuits. Locate and name the type of oscillator in the circuit: Armstrong, Hartley, Colpitts or Clapp.
26.27	To construct a basic series-fed Hartley oscillator. (IL)	Construct the circuit and make changes in the circuit and note the effect on the circuit operation. Calculate the resonant frequency. Observe the output waveform on an oscilloscope and record the frequency. Shunt the capacitor in the resonant circuit with another capacitor of equal size and note the effect on the frequency. Remove the bias resistor connected to the transistor while the circuit is oscillating and note the effect on the circuit. List typical applications and limitations of the Hartley oscillator.
26.28	To construct a basic series-fed Colpitts oscillator, make changes in the circuit and note the effect. (IL)	Construct the circuit and check the operation. Calculate the resonant frequency. Observe the output on an oscilloscope and note the frequency. Change the feedback capacitor in the tapped capacitor arrangement and note the effect on the oscillator. Use three samples ranging from small to large in the value of the capacitor. List typical applications and limitations of the Colpitts oscillator.
26.29	To construct a crystal oscillator circuit and observe the results. (IL)	Construct the circuit and check the operation. State what determines the natural frequency of the crystal. List the advantages and disadvantages of using a crystal oscillator.

Module 27A: Communications, Radio (Optional)

Suggested time: 10 - 15 hours **Level:** Intermediate
Prerequisite: Module 26B

Foundational Objectives
- To use appropriate terminology for electricity or electronics in context.
- To become knowledgeable of the various principles and characteristics of electricity and electronics.

Common Essential Learnings Foundational Objectives
- To describe and compare AM and FM systems of communications. (COM)
- To use technological "know how" and tools to extend human capabilities. (TL)
- To strengthen students' understanding by applying knowledge of numbers and their interrelationships. (NUM)

	Learning Objectives	Notes
	AM COMMUNICATIONS	
27.1	To draw a block diagram of an AM transmitter. (COM)	Explain to students and discuss the purpose of each section of a transmitter.
27.2	To draw a block diagram of an AM receiver. (COM)	Discuss the action of an AM waveform and the action of the receiver.
27.3	To list the characteristics of the AM waveform.	Investigate and list the characteristics of the wave. Have students identify advantages and disadvantages of AM communication.
	FM COMMUNICATIONS	
27.4	To draw a block diagram of an FM transmitter. (COM)	Discuss the purpose of each section.
27.5	To draw a block diagram of an FM receiver.	Provide an explanation of the purpose of each section.
27.6	To list the characteristics of the FM waveform.	Discuss the action of an FM waveform.
27.7	To list two advantages and two disadvantages of FM communication. (COM, CCT)	Have the students investigate the characteristics of the wave. Determine the advantages and disadvantages of FM communication.

Module 27B: Communications, Antennas (Optional)

Suggested time: 10 - 15 hours **Level:** Advanced
Prerequisite: Module 27A

ANTENNAS

	Learning Objectives	Notes
27.8	To list two common types of antennas used for transmission and reception.	Provide pictures or samples of antennas.
.		
27.9	To draw the radiation pattern for a half-wave dipole.	Use illustrations of transmission patterns available in communications manuals.
27.10	To calculate the length of a half-wave dipole. (NUM)	Provide a desired frequency.
27.11	To explain the propagation of a radio wave. (COM, CCT)	Provide students with an explanation of the phenomenon of wave propagation.

Module 27C: Communications, Fibre Optics (Optional)

Suggested time: 10 - 15 hours **Level:** Advanced
Prerequisite: Module 27B

	Learning Objectives	Notes
	FIBRE OPTIC PRINCIPLES	
27.12	To describe the historical development of fibre optics. (COM)	Students will research and write a report on the history of the industry. Some pioneering applications of fibre optic applications occurred in Saskatchewan.
27.13	To describe the physical characteristics of bundled and single fibres. (COM)	Provide students with data sheets describing the characteristics of fibre optic cables.
27.14	To describe how light is propagated in a fibre optic conductor. (COM)	Have students set up a lab involving a light source and observe the transmission through a fibre.
	FIBRE OPTIC CHARACTERISTICS	
27.15	To list four sources of light for use in fibre optics.	
27.16	To describe the types of losses associated with fibre optics.	Discuss losses associated with fibre optic material, light dispersion- absorption, scattering and bending.

Module 28: Ultrasonics (Optional)

Suggested time: 8 - 15 hours **Level:** Advanced
Prerequisite: Module 27C

Foundational Objectives
- To use appropriate terminology for electricity or electronics in context.
- To become knowledgeable about the various principles and characteristics of electricity and electronics.

Common Essential Learnings Foundational Objectives
- To identify and describe applications for ultrasonics. (COM)
- To compare ultrasonics with sound.
- To identify and describe applications for ultrasonics.

	Learning Objectives	Notes
	SOUND AND ULTRASONIC FREQUENCIES	
28.1	To identify the frequencies associated with ultrasonics.	
28.2	To describe the wave motion of ultrasonics. (COM)	Explain the wave motion of ultrasonics. Compare it to other wave motions.
28.3	To explain the effect of a solid, liquid or gas on the speed of wave travel.	Calculate the effect by relating the motion to the density of the medium. (NUM)
	APPLICATION OF ULTRASONICS	
28.4	To describe the use of ultrasonics in cleaning, flaw detection, welding, treatment of tumors and cancers, medical observations, fish detection and burglar alarm systems. (TL)	Have students select an application. Research that application for presentation to the rest of the class.

Module 29A: Digital Concepts (Core)

Suggested time: 10 - 15 hours **Level:** Intermediate
Prerequisite: Module 28

Foundational Objectives

- To use appropriate terminology for electricity or electronics in context.
- To become knowledgeable of the various principles and characteristics of electricity and electronics.
- To design and/or build circuits to an acceptable standard capable of producing a desired output.

Common Essential Learnings Foundational Objectives

- To use the language of digital circuitry, using both symbolic and Boolean forms, to logic gate. (COM)
- To strengthen students' understanding through applying knowledge of numbers. (NUM)

	Learning Objectives	Notes
	BINARY STATES	
29.1	To identify devices that exhibit binary states.	Give examples of binary devices in the immediate surroundings.
29.2	To calculate the number of input combinations for an n-input binary system. (NUM)	Provide the students with a number for the input.
	GATES	
29.3	To draw the circuit symbol and truth table for each of the following gates: n-input and, or, inverter, negation, NAND, NOR, exclusive-OR and exclusive NOR gates. (CCT, IL)	Students use data sheets to locate symbols and to draw truth tables.
29.4	To write a single truth table for a 3-input device. (CCT, COM)	The outputs must perform the operation AND, NAND, OR and NOR.

Module 29B: Digital Concepts (Core)

Suggested time: 10 - 15 hours **Level:** Advanced
Prerequisite: Module 29A

	Learning Objectives	Notes
	BOOLEAN EXPRESSIONS AND CIRCUIT SYMBOLS	
29.5	To write a Boolean expression using the operators AND, OR and NEGATION. (COM)	Provide students with information on Boolean expressions.
29.6	To convert a Boolean expression to a logic gate circuit. (NUM)	Provide the Boolean expression.
29.7	To convert a logic gate circuit to a Boolean expression.	Provide the logic gate circuit.
	DEMORGAN'S THEOREM	
29.8	To state Demorgan's theorem.	Have students locate the theorem and explain it in their own words.
29.9	To apply Demorgan's theorem to a Boolean expression. (CCT)	Provide the students with a Boolean expression.
29.10	To apply Demorgan's theorem to a logic gate circuit.	Provide a logic gate circuit for the students to examine.

Module 29C: Digital Concepts (Core)

Suggested time: 10 - 15 hours **Level:** Advanced
Prerequisite: Module 29B

	Learning Objectives	Notes
		LOGIC CIRCUIT DESIGN
29.11	To design a logic gate circuit.	Design a circuit using only 2-input NAND/NOR gates that enables engine ignition only when the driver and passenger have their seat belts connected.
29.12	To verify the design.	Verify the design of the circuits in 29.11 by drawing up a truth table.
29.13	To test the circuit functions against the truth table.	Build the logic circuit in 29.11 and verify the operation.

Module 30A: Digital Circuits (Core)

Suggested time: 10 - 15 hours **Level:** Intermediate
Prerequisite: Module 29C

Foundational Objectives
- To use appropriate terminology for electricity or electronics in context.
- To become knowledgeable about the various principles and characteristics of electricity and electronics.
- To design and/or build circuits to an acceptable standard capable of producing a desired output.

Common Essential Learnings Foundational Objective
- To use the vocabulary, make comparisons and apply the principles of digital electronics. (COM)

	Learning Objectives	Notes
		CODES: ENCODING and DECODING
30.1	Compare codes used in digital electronics: binary, hexadecimal, 8421 BCD, excess-3 and Gray code. (CCT)	Convert numbers from one code to another. Explain the application for each code. State the advantages and disadvantages for each code.
30.2	Describe the operation of a seven-segment display. (COM)	Draw and label the segments of a seven-segment display and indicate the pin numbers connected to each segment. Test a seven-segment display and determine whether it is common, anode or cathode.
30.3	Explain the operation of the encoder, decoder and driver. (COM, CCT, TL)	Construct a circuit that will display a decimal number.
30.4	Compare an LED display to an LCD display and list two advantages of using the LCD. (COM, CCT)	Provide schematic diagrams and data sheets describing the two types of displays.
		FLIP-FLOPS
30.5	To explain the operation of the R-S flip-flop. (COM)	Have the students connect the circuit and describe the operation.
30.6	To explain the operation of the D flip-flop.	
30.7	To describe the operation of the J-K flip-flop and explain why it is so widely used.	

Module 30B: Digital Circuits (Core)

Suggested time: 10 - 15 hours **Level:** Advanced
Prerequisite: Module 30A

	Learning Objectives	Notes
		COUNTERS
30.8	To describe how binary counting is accomplished.	Provide the students with a data sheet for a counter. Have them explain the operation.
30.9	To compare an up counter to a down counter and explain the difference in operation.	Provide data sheets to help explain the operation of the counter.
30.10	To explain the operation of a circuit used for frequency division.	Connect a circuit based on a schematic diagram for frequency division.
		SHIFT REGISTERS
30.11	To compare the operation of a serial and parallel shift register.	Set up the circuits and observe the operation of each.
30.12	To describe the advantages of using a universal shift register. (COM)	Compare the universal shift register to the circuits in 30.11.

Module 30C: Digital Circuits (Core)

Suggested time: 10 - 15 hours **Level:** Advanced
Prerequisite: Module 30B

	Learning Objectives	Notes
	CONVERTERS	
30.13	To explain the processes of D/A and A/D conversion. (COM, CCT)	Discuss the processes. Construct circuits that have an analog input and digital output as well as a circuit that has digital input and analog output.
30.14	To explain the operation of a comparator.	Construct a circuit using op amps to compare voltages and indicate which voltage is greater.
30.15	To describe the operation of a simple digital circuit.	Build a breadboard to illustrate a simple digital circuit and explain the operation.

Module 31: Robotics (Optional)

Suggested time: 5 - 10 hours **Level:** Introductory
Prerequisites: Module 1A, 2A

Foundational Objectives
- To increase self-esteem from success with equipment, materials and techniques used.
- To work safely and cooperatively with other students and handle materials in a safe manner.

Common Essential Learnings Foundational Objectives
- To develop students' skills and abilities to identify their own learning needs. (IL)

	Learning Objectives	Notes
		ROBOTIC MOTION
31.1	To identify the major parts of a robot. (COM)	Research where and how robots are used in industry. Provide a robot for students to examine.
31.2	To manipulate a robot manually. (IL)	Calibrate the robot giving it a home position. Manipulate the robot to pick-and-place an object and record the required steps for repeated performance.
31.3	To manipulate a robot using computer program.	Connect the robot to a computer, design a program to perform a pick-and-place operation, edit the program for any errors and test the program for repeatability.

Module 32A: Computer Recycling (Optional)

Suggested time: 5 - 10 hours **Level:** Introductory
Prerequisites: Module 1A, 2A

Foundational Objectives
- To become knowledgeable about the various principles and characteristics of electricity and electronics.
- To use and interpret meter readings.
- To test and evaluate the integrity of electrical and electronic components.

Common Essential Learnings Foundational Objectives
- To develop students' abilities to access knowledge. (IL)
- To participate in creative problem solving within the field of electronics. (CCT)
- To use technological knowledge and tools to extend human capabilities. (TL)

This module presents possibilities for cooperation or integration with a computer science class.

	Learning Objectives	Notes
32.1	To identify and record the type of computer being disassembled. (COM)	Provide a computer for recycling. There are many salvage operations that may be willing to donate computers to disassemble. Have students record type of motherboard, BIOS, chipset, drives, slots and cards.
32.2	To test each of the components intended for recycling. (CCT, TL)	Connect or insert the intended component in a working compatible computer and note the results. Catalogue and store parts for future use.
32.3	To reassemble a computer for use. (TL)	Select components from tested stock and reassemble a computer from compatible parts. (IL)
32.4	To install an operating system. (TL)	Select a suitable operating system that is compatible with the components.

Module 32B: Computer Recycling (Optional)

Suggested time: 5 - 10 hours **Level:** Intermediate
Prerequisites: Modules 1A, 2A, 32A

Review or repeat Module 32A as required before continuing to this module at the 30 level.

Module 33A, B, C: Work Study Preparation and Follow-up Activities (Optional)

Note: Module 33 Work Study Preparation and Follow-up Activities is 5 to 10 hours. If students have participated in a work study module in a previous Practical and Applied Arts course, a review of this module is still required but less time is needed.

Suggested time: 5 - 10 hours
Prerequisite: None

Module Overview
Students will prepare for work study in the community. Expectations for the student, the teacher, and the employer should be discussed. During follow-up, students will reflect on work study experiences.

Foundational Objectives
- To develop workplace skills, knowledge, and attitudes in the electrical and electronics industry that may lead to successful employment.
- To understand how skills acquired in school may transfer to the workplace.

Common Essential Learnings Foundational Objective(s)
- To demonstrate skills and attitudes that contribute to the development of positive human relationships. (IL, PSVS)

Note: Other CELs may be emphasized.

	Learning Objectives	Notes
33.1	To be aware of the expectations of each of the partners in the work study component.	In order to establish a successful working relationship with all the partners involved in the workplace, it is important to define the expectations of each partner. For a list of roles and responsibilities of the business, personnel, manager, teacher monitor, school, parent and student, see the Work Study Guidelines for the Practical and Applied Arts included in the *Practical and Applied Arts Handbook*.
33.2	To determine the factors that may affect the student's contribution in the workplace. (CCT)	Brainstorm a list, then verify through experience. The list may include previous work experience, volunteer work, teamwork activities and extra-curricular participation within the school.
33.3	To build good communication skills for the workplace. (COM, PSVS)	Discuss verbal and non-verbal communication. List some ways in which negative and positive non-verbal communication may be displayed. Encourage students to role play ways of demonstrating effective techniques of verbal communication on the job when giving or receiving instructions and resolving conflict. Use case studies, and divide the students into groups to role play how effective communication may be used to resolve conflict on the job. Emphasize the Employability Skills (from the Conference Board of Canada) and compare them to the Common Essential Learnings of Saskatchewan's curriculum. Make the direct link between skill development in this course, and the needs of employers. Development of skills and documentation of the skills leads to employment using those skills.

	Learning Objectives	Notes
33.4	To develop a resumé that may be forwarded to a potential employer.	The student will develop a resumé using the correct format. (IL) The resumé may be used to introduce the student to the employer of a workplace site prior to an interview. Teachers are encouraged to work with other staff members to ensure resumé preparation is taught. Resumé writing is covered in *English Language Arts 20 and A30*, *Information Processing 10, 20, 30*, and *Career and Work Exploration 20* curriculum guides. Students should save the resumé and update it as changes need to be made and as references are added. Skills that have been developed can also be added to the updated resumé.
33.5	To create a student guide in preparation for an interview.	Students should develop their resumés and update them during the course, as work placement references are accumulated. A discussion with students about the benefits of a portfolio of sample work is appropriate at this time. A personal website that highlights the student's skills and training might be created and referred to in the resumé. If students have already completed a resumé and cover letter in another course, the teacher may do a review and encourage students to update their information. Each student should submit a résumé for teacher approval prior to going to an interview or directly to the workplace.
33.6	To determine student guidelines in preparation for an interview. (COM)	Through a classroom discussion or in groups, students should compile a "guide" for job interviews. After the students formulate their guide, the teacher may prompt them for missing items. Outline and describe the three stages of an interview. Point out to students at which stage of the interview each of the guidelines previously discussed will be used. The **greeting** involves an introduction between the student and employer. Discuss or demonstrate how this should be done. The **exchange** is the longest part of the interview where the employer asks a series of questions and engages in a dialogue with the student about information on the resumé and other matters relating to the job. A student's portfolio may be examined by the employer as part of the exchange. The **parting** provides closure to the interview and may be just as important as the greeting. Explain how this may be done. Provide the students with a list of questions frequently asked by employers or ask students to make a list. Students may role play the stages of the interview.

| | Learning Objectives | Notes |

33.7	To discuss the post interview.	After the student has completed the interview with the employer, do a follow-up activity. Review the interview with the student using the three stages above as points for discussion.
33.8	To develop a procedural guide for the work site.	Discuss the following work site items with students: • transportation • hours of work • absence and tardiness • procedures for conflict resolution • role of the student, teacher, and workplace supervisor • dress code • job description • school and employer expectations.
33.9	To relate feedback from the work placement.	Students provide feedback about work placement including: location, type of business, duties, most rewarding experience, most difficult situation and how they handled it. Note: It is recommended that each student send a thank you note or card to the employer upon the completion of each work placement. If more than one placement has been made in the course, follow-up activities must be completed after each placement. Ensure that students understand these guidelines by asking students to describe each of these items. Note: Look for opportunities to introduce and reinforce ideas about Labour Standards, Occupational Health and Safety and WHMIS. Use the *Career and Work Exploration Curriculum Guide*, the *Practical and Applied Arts Handbook*, the Saskatchewan Labour website (www.readyforwork.sk.ca) and other resources recommended in the accompanying bibliography.

Module 34A, B, C: Work Study (Optional)

Suggested time: 25 - 50 hours
Prerequisite: Module 33

Module Overview
Students will be placed in the community working with a mentor and/or a supervisor. They may have the opportunity to learn to use software, to practise previously learned skills, and to learn skills not being taught at their school. Students will be engaged in experiential activities in the workplace.

Foundational Objectives
- To provide students with experience in the electrical and electronics industry that will enable them to make informed career decisions.
- To foster employability skills related to the electrical and electronics industry.
- To integrate classroom learning with work-based learning.

Common Essential Learnings Foundational Objectives
- To engage in a work study experience and develop entry level workplace skills that may lead to sustainable employment. (PSVS)
- To expand career research beyond the classroom setting. (IL)

For more information about implementing work study in schools, see the Work Study Guidelines for the Practical and Applied Arts included in the *Practical and Applied Arts Handbook*. Teachers need to use or design appropriate learning objectives for this module; for instance, to demonstrate ability to follow a "Training Plan". The training plan for the student should be designed to relate to the objectives of the course modules chosen in collaboration with the cooperating employer. See Appendix B in this guide.

Note: *Career and Work Exploration 10, 20, A30, B30 Curriculum Guide* will be released in fall 2001. Consult Saskatchewan Labour for content about Labour Standards, Occupational Health and Safety and WHMIS. If several work study opportunities are offered, they will add more depth to the next experience.

Module 99A, B, C, D: Extended Study (Optional)

Note: The extended study module may be used only once in a pure or survey course. It is important to record the title of the extended study module on the recordkeeping chart. Record 99A for the first extended study module offered in the course series (10, 20, A30, B30), 99B for the second extended study module offered, etc.

Suggested time: 5 - 20 hours **Level:** Introductory/Intermediate/Advanced

Module Overview
Evolving societal and personal needs of society, advances in technology and demands to solve current problems require a flexible curriculum that can accommodate new ways and means to support learning in the future. The extended study module is designed to provide schools with an opportunity to meet current and future demands that are not addressed in current modules in the renewed PAA curriculum.

The flexibility of this module allows a school/school division to design **one new module per credit to complement or extend the study of pure, core and optional modules** configured to meet the specific needs of students or the community. The extended study module is designed to extend the content of the pure courses and to offer survey course modules (see page 9) beyond the scope of the available selection of PAA modules.

The list of possibilities for topics of study or projects for the extended study module approach is as varied as the imagination of those involved in using the module. These optional extended study module guidelines should be used to strengthen the knowledge, skills and processes advocated in the Practical and Applied Arts curriculum.

For more information on the guidelines for the Extended Study module see the *Practical and Applied Arts Handbook*.

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Appendix A: Determining an Apprenticeship Route

During the renewal of the Practical and Applied Arts (PAA), Saskatchewan Education has signed an articulation agreement for Electricity with Saskatchewan Post-Secondary Education and Skills Training (SPEST), Apprenticeship and Trade Certification Commission (ATCC) and Saskatchewan Institute of Applied Science and Technology (SIAST).

Before school divisions start or renew a program in Electrical, they must be aware that the *Electrical and Electronics Curriculum Guide* requires a certain level of student maturity. Certain modules are recommended for Middle Level and the modules available for grade 9 students are listed in the PAA Survey Guideline section of the *Practical and Applied Arts Handbook*.

Pure 100 hour courses are available in the *Electrical and Electronics Curriculum Guide* beginning at the grade 10 Level. Students may take Electrical 10, 20, A30, B30 with no intent to pursue a related career.

Articulation

Saskatchewan Education, in consultation with the PAA Reference Committee, has agreed to develop adequate hours of provincial curriculum in the various designated trades areas of high school curriculum. They also agreed to provide limited practical experience, to meet the Level I requirements (or their equivalent), as outlined by the Apprenticeship and Trade Certification Commission (ATCC) of Saskatchewan Post-Secondary Education and Skills Training (SPEST), in collaboration with the Trade Board (TB).

Articulation agreements among the educational partners have been established to accommodate high school graduates who have met the Level I requirements outlined in the high school curricula and who have followed the procedures specified by the *ATCC High School to Apprenticeship: Linking to the Future. A Handbook for High School Administrators and Student Counsellors*. Those students may challenge the
Level I trade exam. Successful students will receive Level I theory advanced standing in appropriate SIAST programs, and Prior Learning Assessment Recognition (PLAR) time credit hours for time spent with a journeyperson in the workplace, toward apprenticeship standing in the trade.

Training plans included in Appendix B have been designed to provide direction for Level I skill development in the classroom and in the workplace.

School divisions/schools seeking Electrical articulation with Apprenticeship for students graduating from high school may register and challenge the Level I exam, by completing the following steps:

- Everyone must have studied *High School to Apprenticeship: Link to the Future* (1999*)*.
- The Level I theory identified below in Appendix A of this *Electrical and Electronics Curriculum Guide* must be covered thoroughly by the certified teacher and students.
- Practical experiences must be simulated in the school setting or through the optional work study modules used in partnership with local businesses and journeypersons.
- **If the teacher is not a journeyperson, the teacher must take an approved accreditation course. This will provide the necessary background skills to evaluate Level I theory and practice in their school, for students who are following the trade pathway to apprenticeship.**

The accreditation course would require the approval of each of the following: Saskatchewan Education, ATCC, SIAST, SIEA and the STF.

- To challenge Level I, the teacher should recommend only those students who have successfully completed the Level I practical and who have aspirations of pursuing further training in the apprenticeship trade. Registration for the Level I exam is managed by ATCC. Students challenging the Level I apprenticeship theory exam must attain a mark of 70% to pass; therefore, they should probably be achieving at the 80% range or higher in all aspects of the apprenticeship course guide.

- The students must state their intention to write the Level I exam prior to the successful completion of the final high school course(s) and they must receive permission to proceed from the qualified instructor.

- The teacher must notify ATCC at least two months prior to the writing of the Level I exam, stating the intention to have students write and indicating the number of exams required. Verification of the high school trade course marks and the examination fee must be submitted for each student eligible to write.

- The ATCC will administer the Level I exams to high school students during the January and June Departmental Examination writing sessions as arranged. The dates for the writing weeks are established annually and distributed to the schools in the *Registrar's Handbook for School Administrators*. (Contact Student Records at Saskatchewan Education).

- Apprenticeship exams will be returned to the ATCC for grading and evaluation.

- Marks will be mailed to the student at the school. ATCC will record the marks for the Level I exams. For more information about trade articulation and a guide, see the *High School to Apprenticeship: Link to the Future* document developed by ATCC.

- SIAST and ATCC will make notification of change to the Level I apprenticeship requirements in the trade to teachers via the Evergreen Curriculum web-site at Saskatchewan Education.

- ***A high school graduate who has already received all the Secondary Level credits for Electricity and who passes the Level I exam will receive 300 hours of advanced standing in the Electrician program at SIAST. Those students will also receive time credit recognition for practical experience under a journeyperson, provided appropriate documentation has been maintained.***

The following Saskatchewan Education PAA *Electrical and Electronics 10, 20, A30, B30 Curriculum Guide* modules must be successfully completed in order to meet the Level I requirements in the trade:

MODULE	TITLE	HOURS
Module 1	Safety and Health	8-15
Module 2	Concepts About Electricity	15-25
Module 3	Electrical Principles of Alternating Current Circuits and Transformers	8-15
Module 4	Wiring Circuits	15-25
Module 5	Basic Relays and Relay Circuits	10-20
Module 6	Conductors	3-5
Module 7	Overcurrent Devices	10-15
Module 8	Residential Wiring Methods	30-40
Module 9	Residential Circuits and Service	25-40
Module 12	Residential Lighting	15-25
Module 14	Single Phase Power Transformers	5-10
Module 18	Cells and Small Voltage Sources	10-15
Module 19	Measuring Instruments (Meters)	5-10

The above modules have fidelity with the following SIAST modules:

BT120 Basic Theory, Electricity
BT 121 Basic Theory, Cells and Batteries
BT123 Basic Theory, Power Loads
WM120 Wiring Methods
BWC122 Extra Low Voltage Controls
BWC120 Basic Wiring Circuits, Regulations
BWC121 Basic Wiring Circuits, Conductors
PLS120 Single Dwelling Service Requirements
PLS121 Electrical Drawings

Appendix B: Training Plan Checklist 10

Electrical 10: Introductory Skills Checklist

- To be used at the 10 level.
- Recordkeeping documents should be recorded on school letterhead stationary and maintained in the student's cumulative record.

Dates: _____

Student's Name: _____

Business name: _____

Checker's name and qualification_____

Module Component	Observed	Assisted	Demonstrated	Checked By
Module 1: Safety and Health: *demonstrates and practises safe work habits with tools and materials necessary to the trade.*				
Module 2: Concepts About Electricity: *understands the terminology and atomic theory that applies to electricity, including Ohm's Law and Watt's Law and series and parallel circuitry.*				
Module 3: Electrical Principles of Alternating Current Circuits and Transformers: *understands the principles of alternating current and the basic construction of a transformer.*				
Module 4: Wiring Circuits: *understands and applies the code rules and safety practices that apply to the electrical circuitry used in homes.*				
Module 6: Conductors: *understands the uses of conductors in the electrical trade*				
Module 7: Overcurrent Devices: *understands the different types of circuit protection devices and their function as used in the electrical trade.*				
Module 17: Introduction to Electronics: *understands and applies various basic principles, makes various calculations and observations related to electronics.*				
Module 18: Cells and Small Voltage Sources: *understands and describes general characteristics of dry cells and batteries and makes calculations related to batteries.*				
Module 19: Measuring Instruments: *understands, explains and uses a variety of meters that apply to AC and DC circuits.*				
Module 22: Soldering, Desoldering and Recycling Components: *installs and/or removes and reuses electronic components.*				

Appendix B: Training Plan Checklist 20

Electrical 20: Intermediate Skills Checklist

- To be used for Work Study.
- Recordkeeping documents should be recorded on school letterhead stationary and maintained in the student's cumulative record.

Dates: _____

Student's Name: _____

Business name: _____

Checker's name and qualification: _____

Module Component	Observed	Assisted	Demonstrated	Checked By
Module 1: Safety and Health: *demonstrates and practises safe work habits with tools and materials necessary to the trade.*				
Module 2: Concepts About Electricity: *understands the terminology and atomic theory that applies to electricity, including Ohm's Law and Watt's Law and series and parallel circuitry.*				
Module 3: Electrical Principles of Alternating Current Circuits and Transformers: *understands the principles of alternating current and the basic construction of a transformer.*				
Module 4B: Wiring Circuits: *understands and applies the code rules and safety practises that apply to the electrical circuitry used in homes.*				
Module 5: Basic Relays and Relay Circuits: *understands the characteristics and principles of magnetism and its application to signalling mechanisms and relays.*				
Module 7: Overcurrent Devices: *understands the different types of circuit protection devices and their function as used in the electrical trade.*				
Module 8: Residential Wiring Methods: *understands and uses schematic and wiring diagrams and applies that knowledge by wiring common residential circuits using appropriate tools and equipment.*				
Module 9: Residential Circuits and Service: *makes appropriate decisions and does the necessary calculations to provide a complete electrical service to a residence.*				

Module Component	Observed	Assisted	Demonstrated	Checked By
Module 13: Alternating Current: Theory and Circuits: *demonstrates understanding of inductive and capacitance circuits and does appropriate*				

calculations.				
Module 17: Introduction to Electronics: *understands and applies various basic principles, makes various calculations and observations related to electronics.*				
Module 18: Cells and Small Voltage Sources: *understands and describes general characteristics of dry cells and batteries and make calculations related to batteries.*				

Appendix B: Training Plan Checklist A30

Electrical A30: Advanced Skills Checklist

- To be used for Work Study which can begin at the 20 level.
- Recordkeeping documents should be recorded on school letterhead stationary and maintained in the student's cumulative record.

Dates: _____

Student's Name: _____

Business name: _____

Checker's name and qualification_____

Module Component	Observed	Assisted	Demonstrated	Checked By
Module 1: Safety and Health: *demonstrates and practises safe work habits with tools and materials necessary to the trade.*				
Module 2: Concepts About Electricity: *understands the terminology and atomic theory that applies to electricity, including Ohm's Law and Watt's Law and series and parallel circuitry.*				
Module 4: Wiring Circuits: *understands and applies the code rules and safety practices that apply to the electrical circuitry used in homes.*				
Module 5: Basic Relays and Relay Circuits: *understands the characteristics and principles of magnetism and its application to signalling mechanisms and relays.*				
Module 8: Residential Wiring Methods: *understands and uses schematic and wiring diagrams and applies that knowledge by wiring common residential circuits using appropriate tools and equipment.*				
Module 9: Residential Circuits and Service: *makes appropriate decisions and does the necessary calculations to provide a complete electrical service to a residence*				
Module 10: Direct Current Generators: *identifies and connects different types of direct current generators.*				
Module 11: Direct Current Motors: *understands the applications for DC motors and connects them in different rotations and speeds.*				
Module 12: Residential Lighting: *understands how light is produced and makes appropriate installations.*				

Module Component	Observed	Assisted	Demonstrated	Checked By
Module 13: Alternating Current: Theory and Circuits: *demonstrates understanding of inductive and*				

capacitance circuits and does appropriate calculations.				
Module 14: Single Phase Power Transformers: *identifies characteristics of transformers and troubleshoots problems in transformer operation.*				
Module 15: Alternating Current Motors: *identifies various types, principles and characteristics of motors and draws their schematic diagrams.*				
Module 19: Measuring Instruments: *understands, explains and uses a variety of meters that apply to AC and DC circuits.*				

Appendix B: Training Plan Checklist B30

Electrical B30: Advanced Skills Checklist

- To be used for Work Study.
- Recordkeeping documents should be recorded on school letterhead stationary and maintained in the student's cumulative record.

Dates: _____

Student's Name: _____

Business name: _____

Checker's name and qualification: _____

Module Component	Observed	Assisted	Demonstrated	Checked By
Module 1: Safety and Health: *demonstrates and practises safe work habits with tools and materials necessary to the trade.*				
Module 2: Concepts About Electricity: *understands the terminology and atomic theory that applies to electricity, including Ohm's Law and Watt's Law and series and parallel circuitry.*				
Module 5: Basic Relays and Relay Circuits: *understands the characteristics and principles of magnetism and its application to signalling mechanisms and relays.*				
Module 8: Residential Wiring Methods: *understands and uses schematic and wiring diagrams and applies that knowledge by wiring common residential circuits using appropriate tools and equipment.*				
Module 9: Residential Circuits and Service: m*akes appropriate decisions and does the necessary calculations to provide a complete electrical service to a residence*				
Module 10: Direct Current Generators: *identifies and connects different types of direct current generators.*				
Module 11: Direct Current Motors: *understands the applications for DC motors and connects them in different rotations and speeds.*				
Module 12: Residential Lighting: *understands how light is produced and makes appropriate installations.*				

Module Component	Observed	Assisted	Demonstrated	Checked By
Module 14: Single Phase Power Transformers: *identifies characteristics of transformers and troubleshoots problems in transformer operation.*				
Module 15: Alternating Current Motors: *identifies various types principles and characteristics of motors and draws their schematic diagrams.*				
Module 16: Motor Starters and Controls: *understands manual and magnetic starters and how to connect them to different motor circuits.*				

Appendix C: Student Assessment

Personal Development

Name: _____ Date: _____

Ability The student is able to:	Meets Expectations ✓	Remarks
Personal Development		
Generate new ideas and work in a group structure.		
Respect the rights of others.		
Practise safety.		
Identify environmental issues.		
Develop time management skills and schedule school work assignments.		
Communicate effectively with supervisors and peers.		
Recognize the need for quality workmanship.		
Develop a positive attitude towards personal wellness.		
Be a team player.		
Describe business requirements and expectations.		
Develop quality improvement strategies.		
Participate in positive personal activities.		

Student Assessments

Processing and Production

Name: _____ Date: _____

Ability The student is able to:	Meets Expectations ✓	Remarks
Processes and Production		
Plan, prepare and organize practical tasks and projects.		
Fabricate and assemble basic projects.		
Display quality work.		
Apply basic measures of quality.		
Work independently and in small groups.		
Relate time, quality and processes to project construction.		
Fabricate electrical/electronic sub-assemblies and projects.		
Populate circuit boards.		
Identify and apply electrical connections.		
Apply high reliability soldering techniques.		
Inspect, testand troubleshoot circuits.		
Apply standards of quality to practical projects.		
Interpret technical specifications, drawings and schematic diagrams.		
Apply and report statistical measures of quality.		

Student Assessments

Application of Technology

Name: _____ Date: _____

Ability The student is able to:	Meets Expectations ✓	Remarks
Applied Technology		
Define: electricity, electronics.		
Identify electrical hazards in the home.		
Use tools common to the electrical/electronics industry.		
Draw, label and construct simple electrical/electronic circuits.		
Recognize materials as insulators, conductors or semiconductors.		
List several sources of electricity.		
Define voltage, current, resistance and power.		
Identify safe current, voltage and power values.		
Solder a connection.		
Select and use proper electrical/electronic test equipment.		
Demonstrate the correct methods of connecting electrical meters and obtaining readings.		
Select wire size and insulation of a conductor.		
Select sources of electricity for different applications.		
Identify the size of resistors and capacitors needed in a circuit. Select the power and voltage rating of these components.		
Demonstrate the laws of magnetism and the characteristics of magnetic lines of force.		
Explain the characteristics of electromagnetism.		
Use simple troubleshooting techniques to repair electrical/electronic circuits.		
Identify semiconductor components and integrated circuits for electronic application.		
Construct and test electromechanical circuits, residential circuits and solid state circuits.		
Program different controllers.		
Apply computer software to electrical/electronic areas.		
Work safely.		

Student Assessments

Application of Technology

Name: _____ Date: _____

Ability The student is able to:	Meets Expectations ✓	Remarks
Applied Technology		
Apply provincial and federal electrical safety codes.		
Design, construct, test and troubleshoot AC and DC electrical/electronic circuits.		
Identify the characteristics of digital and analog systems.		
Apply microprocessor procedures to information storage graphics and data management.		
Use electromechanical equipment in manufacturing systems.		
Describe communication technology that relates to the electrical/electronic industry.		
Work safely in the school and on the job site.		

Appendix D: Career Research Interview Questions

Adapted from *Business Education A Curriculum Guide for the Secondary Level Accounting 10, 20, 30* (Saskatchewan Education 1992).

Interview someone who currently works in this career.

The assignment may be completed independently, in pairs, in small groups, or by any method chosen by the student(s) and teacher. The teacher should encourage students to use a variety of resources to gather information about the career that they are researching. The student may use letters, the Internet, phone or a personal interview to gather information.

After the students have discussed different career paths, students may prepare a short journal writing explaining why they are interested in the career area they are about to investigate.

Students may develop a list of questions to collect the information they require, to help them understand more about the career area they have chosen.

The following list of questions may be included in the students' interview project, and would be asked during the interview.

1. What is the title of your job?

2. What are your normal duties on the job?

3. What are some of the things that you enjoy about your job?

4. Are there any things about your job that you dislike? What are those things?

5. Does your company have a dress code for employees? What type of dress is considered suitable?

6. How often is working overtime required in your job?

7. Do you have to work nights or weekends?

8. What aptitudes and abilities are needed to succeed in your career?

9. What are the post-secondary education and training requirements to enter and advance in your career?

10. Can you give an approximate starting salary for someone just starting out in your occupation? How much does the average person earn after five years? After ten years? What types of employee benefits, such as sick leave or dental plans, do workers in your career usually receive?

11. Do you think the demand for workers in your career will increase or decrease over the next five years? Why?

12. What changes have you seen over the past 5-10 years in this career?

13. What are the advantages and disadvantages of entering and being in your career?

14. Is there any advice you would give to a young person just making a career choice?

After the interview session, students may summarize the information they received and draw a conclusion as to whether they would like to learn more about this career. They may also determine whether they would like to join that organization based on their experience.

Students may brainstorm different ways to present their career research to the class. Presentation ideas may include:

- Oral presentation
- Power point presentation
- Written report
- Creating a website with links to career information
- Role playing a student interviewing a career professional
- Role playing a professional promoting his/her career at a career fair.