Skilled Trades Ontario | Métiers spécialisés Ontario

Apprenticeship Curriculum Standard

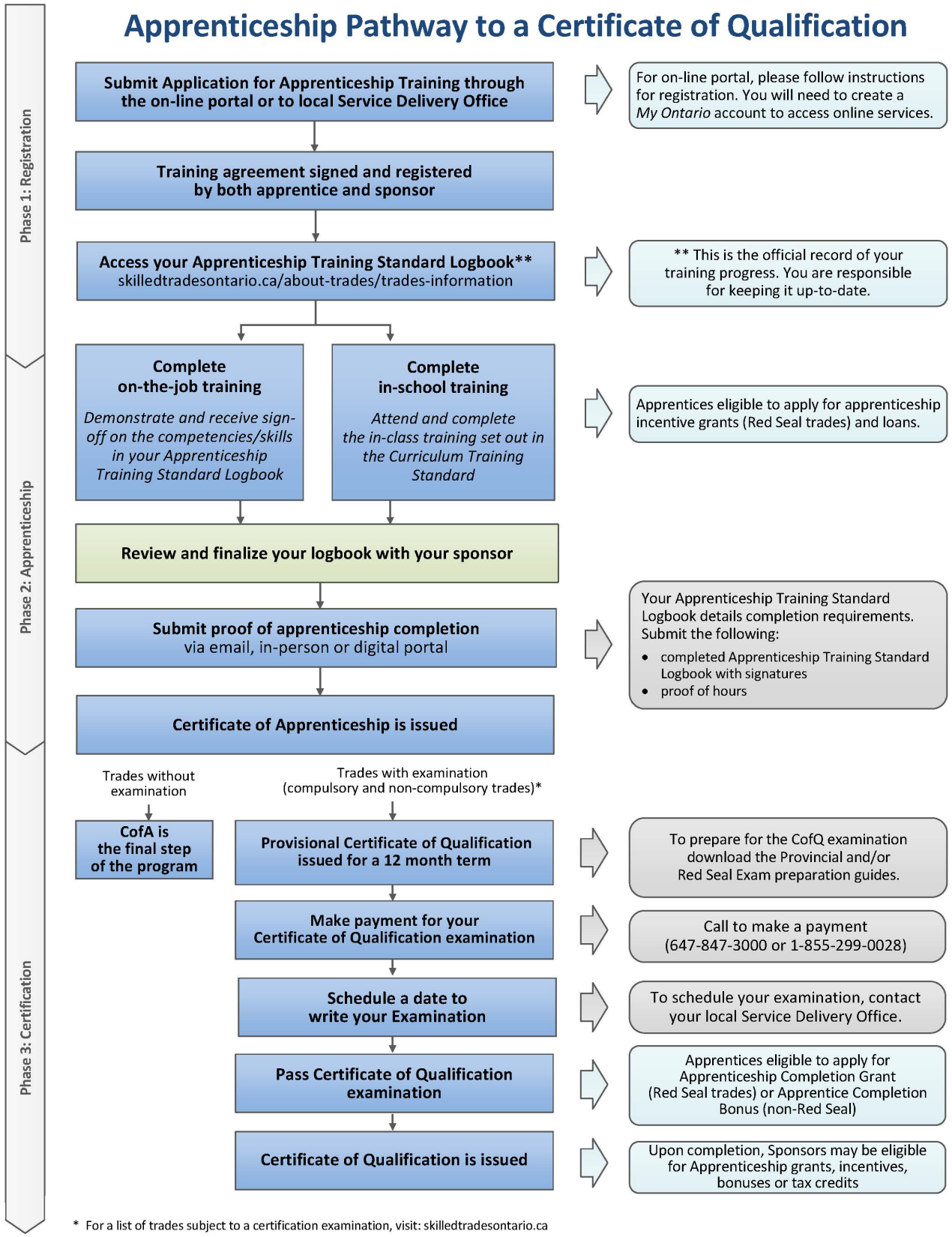
Entertainment Industry Power Technician

Levels 1, 2, 3 and 4

269E

2006

Apprenticeship Pathway to a Certificate of Qualification



* For a list of trades subject to a certification examination, visit: skilledtradesontario.ca

Draft version: 2022-03-16

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Please Note: This Standard has been revised to reflect the visual identity of Skilled Trades Ontario (STO) which replaced the Ontario College of Trades on January 1, 2022. The content of this Standard may refer to the former organization; however, all trade specific information or content remains relevant and accurate based on the original date of publishing.

Please refer to STO's website: **skilledtradesontario.ca** for the most accurate and up to date information. For information about BOSTA and its regulations, please visit ***Building Opportunities in the Skilled Trades Act, 2021* (BOSTA).**

Any updates to this publication are available on-line; to download this document in PDF format, please follow the link: Skilled Trades Ontario.ca.

Maintained with transfer to Skilled Trades Ontario 2006 (V100)

Preface

This curriculum standard for the Entertainment Industry Power Technician trade program is based upon the on-the-job performance objectives, located in the industry-approved training standard.

The curriculum is organized into four (4) levels of training, each including reportable subjects containing learning outcomes to reflect the units of the training standard. The hours charts indicate how the curriculum can be delivered in the current block release format and summarizes the hours of training for each reportable by level. Since the reportable subjects are all divisible by three they can be adapted to accommodate a more flexible training delivery other than block release. The Reportable Subjects Summary chart (located on page 4) summarizes the training hours for each reportable subject.

The reportable subjects are cross-referenced to the training standard for ease of comparison.

Each reportable subject and learning outcome identifies a recommended number of training hours. This hour allotment is broken into hours for instruction in theory and practical application. The division of the curriculum into reportable subjects follows a natural progression of learning through the training program. This structure will allow training centres and apprentices' flexibility in program delivery while still observing the importance of sequencing learning in a logical progression.

The curriculum identifies the learning that takes place in-school. The in-school program focuses primarily on the theoretical knowledge and the essential skills required to support the performance objectives of the Apprenticeship Training Standards.

Employers/Sponsors are expected to extend the apprentice's knowledge and skills through practical training on a work site. Regular evaluations of the apprentice's knowledge and skills are conducted throughout training to verify that all apprentices have achieved the learning outcomes identified in the curriculum standard.

It is not the intent of the in-school curriculum to perfect on-the-job skills. The practical portion of the in-school program is used to reinforce theoretical knowledge. Skill training is provided on the job.

Please refer to Skilled Trades Ontario website (www.skilledtradesontario.ca) for the most accurate and up-to-date information about Skilled Trades Ontario. For information on *Building Opportunities in the Skilled Trades Act, 2021 (BOSTA)*) and its regulations, please visit Building Opportunities in the Skilled Trades Act, 2021, S.O. 2021, c. 28 - Bill 288 (ontario.ca)

Pre-requisites
In order to advance to Level 2 of the apprenticeship program, an individual must have completed all of the units outlined in Level 1. Similarly, in order to advance to Level 3 of the program, an individual must have completed all of the units outlined in Level 1 and 2.

Hours Disclaimer (if applicable)
It is agreed that Training Delivery Agents (TDAs) may need to make slight adjustments (with cause) according to particular apprentice needs and may deviate from the unit sequencing and the prescribed practical and theoretical hours shown within the standard. However, all TDAs will comply with the hours at the reportable subject level.

Suggested Equipment for Training Delivery Agencies
The listing of tools on pages 61, 62, 63 and page 64 does not list minimum quantities based on the understanding that the delivering TDA is in the best position to determine the need based on its delivery methodology.

Personal and Safety Equipment: Personal protective equipment is at the discretion of the TDA who must conform to Ontario Provincial Health and Safety Regulations.

Implementation date:

August 2006

Stakeholders Information

A consortium of two colleges of applied arts and technology, working in collaboration with the Ministry of Training, Colleges and Universities and industry stakeholders, participated in the development of this document. The development and subsequent revisions were based on the new training standards. The development was completed using a process and format approved by MTCU.

The first step in the development process was to assemble a Project Steering Committee (PSC), consisting of both industry representatives and apprenticeship in- school deliverers. The PSC initiated the plan for the project development that followed. The PSC established a working team, responsible for the development of the in-school apprenticeship curriculum document.

The working team worked with advisory groups during the development of the curriculum. The advisory groups were industry representatives who ensured content validity. During various stages of the process, the PSC and participating industry advisory groups evaluated the draft curriculum documents and provided feedback and recommendations for revisions.

Reportable Subject Summary

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
Level 1				
1.	Safe Working Practices	18	9	9
2.	Codes and Standards 1	33	33	0
3.	Communications	12	6	6
4.	Shop Practices	24	0	24
5.	Electrical Theory 1	33	33	0
Level 2				
1.	Safety and Rigging 1	18	9	9
2.	Codes and Standards 2	24	24	0
3.	Electronics 1	21	9	12
4.	Lighting Technology 1	24	8	16
5.	Electrical Theory 2	33	33	0
Level 3				
1.	Safety and Rigging 2	18	9	9
2.	Codes and Standards 3	24	24	0
3.	Electronics 2	21	12	9
4.	Lighting Technology 2	24	8	16
5.	Electrical Theory 3	33	33	0
Level 4				
1.	Installation Methods	18	0	18
2.	Codes and Standards 4	24	24	0
3.	Control Systems	21	9	12
4.	Lighting Technology 3	24	8	16
5.	Electrical Theory 4	33	33	0
	Total	**480**	**324**	**156**

Level 1

Reportable Subject Summary – Level 1

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
1.	Safe Working Practices	18	9	9
2.	Codes and Standards 1	33	33	0
3.	Communications	12	6	6
4.	Shop Practices	24	0	24
5.	Electrical Theory 1	33	33	0
	Total	**120**	**81**	**39**

Number:	1		
Title:	**Safe Working Practices**		
Duration:	Total Hours: 18	Theory: 9	Practical: 9
Prerequisites:	None		
Co-requisites:	None		

Cross-Reference to Learning Outcomes: 5351.01, 5351.02, 5351.03, 5351.05, 5351.06, 5351.09, 5351.10, 5353.04, 5353.05, 5353.06, 5353.07, 5354.02, 5354.03

General Learning Outcome

Upon successful completion of the reportable subject, the apprentice is able to select and safely use scaffolds and accessories in compliance with regulations, codes, and directives, select and use appropriate personal protective equipment, and demonstrate an awareness of fire and safety procedures.

Learning Outcomes

Upon successful completion, the apprentice is able to:

1.1. Demonstrate proper climbing skills with the use of ladders and fall arrest equipment.

1.2. Show how to prevent slips and falls.

1.3. Explain appropriate responses to accidents.

1.4. Explain the importance of eye and hearing protection.

1.5. Select and demonstrate the proper usage of personal protective equipment.

1.6. Explain workers rights and responsibilities under the Occupational Health and Safety Act.

1.7. Explain W.H.M.I.S.

1.8. Explain emergency response to electrical hazards.

1.9. Explain lockout and tag procedures for electrical equipment.

1.10. Explain basic fire suppression techniques.

1.11. Explain the relevant theatrical pyrotechnics legislation.

1.12. Explain pinch points.

1.13. Explain hand safety.

1.14. Demonstrate proper lifting techniques.

1.15. Demonstrate the proper set up and use of scaffold equipment.

1.16. Demonstrate the proper dismantling of scaffolding.

1.17. Reference appropriate legislation for ladders and scaffolds in the Occupational Health and Safety Act.

Instructional/Delivery Strategies:
Practical Lab exercises and projects.
Lecture/discussion.

Reference Materials:
Occupational Health and Safety Act.
Stage Rigging Handbook, Second Edition (Southern Illinois University Press)
Occupational Health and Safety Act.

Minimum Equipment List:
Step ladders, extension ladders.
Fall arrest harnesses and equipment.
Sectional scaffolding and related platforms and accessories.
Personal Protective Equipment including hand and eye protection.

Evaluation Structure	
Theory Testing	Application Exercises
50%	50%

Number:	2		
Title:	**Codes and Standards 1**		
Duration:	Total Hours: 33	Theory:33	Practical: 0
Prerequisites:	None		
Co-requisites:	None		

Cross-Reference to Learning Outcomes: 5355.04, 5355.06, 5356.02, 5356.05, 5356.07, 5357.02, 5357.06, 5359.02, 5359.04

General Learning Outcome

Upon successful completion of the reportable subject, the apprentice is able to demonstrate an awareness of codes, standards, and safety guidelines pertinent to the entertainment industry, including those published by the Canadian Standards Association (CSA), the Electrical Safety Authority (ESA), and the Ministry of Labour (MOL). The apprentice will demonstrate a general knowledge of the general rules and regulations of the Ontario Electrical Code (OEC), and Canadian Electrical Code (CEC) Part 1.

Learning Outcomes

Upon successful completion, the apprentice is able to:

2.1. Define the role of the Ministry of Labour in Ontario.

- 2.1.1 Identify Safety Guidelines published by the Ministry of Labour for the Performance Industry in Ontario (Guidelines).
- 2.1.2 State the relationship of the Guidelines to the Occupational Health and Safety Act.
- 2.1.3 State the safety responsibilities and duties as outlined in the Guidelines and in the Occupational Health and Safety Act.
- 2.1.4 Identify and interpret guidelines specific to the Entertainment Industry Power Technician.

2.2. Define the role of the Electrical Safety Authority (ESA) in Ontario.

- 2.2.1 List ESA’s publications and guidelines as pertain to the entertainment industry.
- 2.2.2 Describe the scope and purpose of ESA Spec 003.
- 2.2.3 Identify entertainment industry job title definitions and general definitions as per ESA Spec 003.

2.2.4 Explain items listed in General Practices of Spec 003.

2.2.5 Explain and interpret regulations under Power Sources in Spec 003.

2.2.6 Interpret Code references from Spec 003 to the Ontario Electrical Code.

2.3. Explain the differences and similarities between the Canadian Electrical Code and provincial Electrical Codes.

2.3.1 Recognize jurisdictional differences.

2.3.2 Recognize regional differences.

2.4. State the objective, scope, and general arrangement of the OEC.

2.5. Identify the method used to indicate code regulation changes in new editions.

2.6. Explain terms as listed in the "Object, Scope and Definition" section of the Code.

2.7. Identify the General Rules of the OEC.

2.8. Apply the OEC regulations for conductors to common installations.

2.9. Explain the OEC regulations regarding grounding and bonding of electrical systems and circuits operating at 750 volts or less.

2.10. Interpret the regulations of the OEC regarding wiring methods for installations operating at 750 volts or less.

2.11. Select and use tables and diagrams related to the general rules of the OEC.

2.12. Calculate ampacity and apply correction factors for single conductors in free air, including conductors in parallel.

2.13. Calculate ampacity and apply correction factors for conductors in a raceway or multi-conductor cable, including conductors in parallel.

2.14. Calculate ampacity and apply correction factors for flexible cords and equipment wires.

Instructional/Delivery Strategies:
Lecture/discussion.
Distributed Learning: paper-based, CD ROM, videos.

Reference Materials:
Ontario Electrical Code book.
Occupational Health and Safety Act.
ESA Spec 003.

Minimum Equipment List:
Classroom: tables and chairs.

Evaluation Structure	
Theory Testing	Application Exercises
100%	0%

Number:	3		
Title:	**Communications**		
Duration:	Total Hours: 12	Theory:6	Practical: 6
Prerequisites:	None		
Co-requisites:	None		
Cross-Reference to Learning Outcomes: 5352.02, 5352.03, 5352.04			

General Learning Outcome

Upon successful completion of the reportable subject, the apprentice is able to demonstrate the skills needed to communicate with individuals and organizations, be able to create written documentation and presentations using a computer.

Learning Outcomes

Upon successful completion, the apprentice is able to:

3.1 Develop effective customer relations through professional conduct.

3.2 Demonstrate the ability to write documents using correct grammar, spelling, and punctuation.

3.3 Develop a basic understanding of personal computer hardware and applications.

3.4 Demonstrate the ability to use a personal computer to generate documentation such as e-mails, letters, memos, and work orders.

3.5 Demonstrate the ability to use a personal computer to develop presentations.

3.6 Describe the uses for the computer as a tool in the entertainment industry.

Instructional/Delivery Strategies:
Lecture/demonstration.
Lab exercises and projects.

Reference Materials:
Online help files, internet resources.

Minimal Equipment List:
Networked multi-media computer lab with internet access.

Evaluation Structure	
Theory Testing	Application Exercises
50%	50%

Number:	4		
Title:	**Shop Practices**		
Duration:	Total Hours: 24	Theory:0	Practical: 24
Prerequisites:	None		
Co-requisites:	None		

Cross-Reference to Learning Outcomes: 5351.01, 5351.04, 5353.01, 5353.02, 5353.03, 5355.01, 5356.01, 5356.02, 5356.04, 5356.05, 5356.06, 5356.07, 5356.08, 5356.09, 5357.05, 5357.06, 5357.07, 5357.09

General Learning Outcome

Upon successful completion of the reportable subject, the apprentice is able to demonstrate the use and operation of common hand and power tools, determine requirements and installation methods for common distribution equipment, install common switching devices, outlets and enclosures as pertain to practicals; terminate conductors; demonstrate the assembly and installation procedures for flexible cords, cables and connectors, install signal and extra-low voltage wiring and devices, identify and terminate copper communication and hard wired cables.

Learning Outcomes

Upon successful completion, the apprentice is able to:

4.1 Identify common distribution equipment and determine service, distribution, grounding, and bonding requirements.

4.2 Demonstrate the correct installation procedures and wiring connections for practicals, including common switching devices and outlets, ensuring strict adherence to CEC regulations.

4.3 Demonstrate the proper installation procedures required for the following wiring methods, while ensuring strict adherence to CEC and Spec 003 regulations:

- 4.3.1 Non-metallic sheathed cable.
- 4.3.2 Armoured cable.
- 4.3.3 Plastic and metallic conduits.
- 4.3.4 Flexible cords.
- 4.3.5 Single conductor cables and connectors.
- 4.3.6 Multiconductor cables and connectors.
- 4.3.7 Category 5 cables.

4.4 Demonstrate the correct techniques for the termination of conductors.

4.5 Determine correct procedures for connections to distribution equipment.

4.6 Identify and determine ampacities and appropriate useage of common industry cables and connectors including:

- 4.6.1 XLR.
- 4.6.2 Cam loc.
- 4.6.3 Stage pin.
- 4.6.4 Twist Lock.
- 4.6.5 U-Ground Edison.
- 4.6.6 Socapex.
- 4.6.7 Amphenol.
- 4.6.8 Category 5 connectors.

4.7 Demonstrate lock-out and tag procedures on common switchgear and devices.

4.8 Identify and terminate copper communication and hard wired cables.

4.9 Demonstrate the correct installation methods for cables and enclosure supports.

4.10 Demonstrate the use of strain reliefs as per ESA Spec 003.

4.11 Demonstrate the safe and proper use of voltage, current, and continuity testers on typical electrical circuits.

4.12 Demonstrate the safe and appropriate use of hand and power tools in the execution of projects.

Instructional/Delivery Strategies:
Demonstration.
Shop projects.

Reference Materials:
Ontario Electrical Code.
ESA Spec 003.

Minimal Equipment List:
Shop space with work benches, wiring booths, and open floor space.
Common electrical distribution equipment and wiring materials.
Common power and hand tools.
Common hand-held meters or multimeters, such as amp-probe, voltage, and continuity testers.

Evaluation Structure	
Theory Testing	Application Exercises
50%	50%

Number:	5		
Title:	**Electrical Theory 1**		
Duration:	Total Hours: 33	Theory: 33	Practical: 0
Prerequisites:	None		
Co-requisites:	None		

Cross-Reference to Learning Outcomes: 5351.01, 5352.01, 5355.04, 5356.02, 5357.08, 5359.07

General Learning Outcome

Upon successful completion of the reportable subject, the apprentice is able to understand electron theory; define voltage, current and resistance, electrical and mechanical power; describe the effects of electricity on the human body; explain the principles of common sources of Electro-Motive Force (EMF); and to analyze series, parallel and combination DC circuits by applying Ohm's Law and Kirchoff's Laws.

Learning Outcomes

Upon successful completion, the apprentice is able to:

5.1 Demonstrate an understanding of electron theory.

- 5.1.1 Explain the theory of atomic structure of elements and molecules.
- 5.1.2 Describe the relationship of electron flow and valence shell electrons.
- 5.1.3 Define characteristics of electrical charges and relative potentials.
- 5.1.4 List insulators, conductors and semiconductors and describe their characteristics.

5.2 Define voltage, current, and resistance.

- 5.2.1 Use unit and quantity symbols to describe voltage, current, and resistance.
- 5.2.2 Describe the electrical characteristics of voltage, current, and resistance.

5.3 List common sources of electricity.

- 5.3.1 Describe chemical sources of electricity and basic battery principles.
- 5.3.2 Describe piezo-electric effect.
- 5.3.3 Describe the fundamental relationship between electricity and magnetism.
- 5.3.4 State the fundamental differences between direct and alternating current.

5.4 Describe the requirements for a simple electrical circuit.

- 5.4.1 Use diagrams to illustrate simple electrical circuits.
- 5.4.2 Use standard symbols to create circuit diagrams.
- 5.4.3 Differentiate between components in series and in parallel.

5.5 Define work, power, and energy.

- 5.5.1 Use standard units to describe work.
- 5.5.2 Use standard units to describe power.
- 5.5.3 Use standard units to describe energy.
- 5.5.4 Convert between units of work power and energy.

5.6 Describe the effects of an electrical current on the human body.

- 5.6.1 State potential hazards electricity poses to personnel.
- 5.6.2 Describe safety procedures used when working with electricity.
- 5.6.3 List methods to ensure personal safety when working with electricity.

5.7 Apply Ohm’s Law to analyze series DC circuits.

- 5.7.1 Define Ohm’s Law.
- 5.7.2 List the characteristics of voltage, current, and resistance in series circuits.

5.8 Apply Kirchoff’s Law to analyze series DC circuits.

- 5.8.1 Define Kirchoff’s Law.
- 5.8.2 Calculate circuit values.

5.9 Apply Ohm’s Law to analyze parallel DC circuits.

- 5.9.1 List the characteristics of voltage, current, and resistance in parallel circuits.
- 5.9.2 Demonstrate the ability to calculate electrical values for discreet components.

5.10 Apply Kirchoff’s Law to analyze parallel DC circuits.

- 5.10.1 Calculate current and voltage division in parallel circuits.

5.11 Apply Ohm's Law and Kirchoff's Law to analyze combination DC circuits.

- 5.11.1 Identify series and parallel paths in a combination circuit.
- 5.11.2 Identify voltage and current divisions within the combination circuit.
- 5.11.3 Calculate voltages, currents, and resistances within discreet components of the combination.
- 5.11.4 Calculate overall circuit power requirements.
- 5.11.5 Describe the interaction of components within the combination.

5.12 Interpret electrical equipment nameplate data in terms of voltage current and power.

Instructional/Delivery Strategies:
Lecture, discussion, class exercises.

Reference Materials:
Herman, Stephen L. (2004). Delmar's Standard Book of Electricity.
New York: Delmar. ISBN 1-4018-2565-6.

Minimal Equipment List:
Standard classroom.

Evaluation Structure	
Theory Testing	Application Exercises
100%	0%

Level 2

Reportable Subject Summary – Level 2

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
1.	Safety and Rigging 1	18	9	9
2.	Codes and Standards 2	24	24	0
3.	Electronics 1	21	9	12
4.	Lighting Technology 1	24	8	16
5.	Electrical Theory 2	33	33	0
	Total	**120**	**83**	**37**

Number:	1		
Title:	**Safety and Rigging**		
Duration:	Total Hours: 18	Theory: 9	Practical: 9
Prerequisites:	None		
Co-requisites:	None		

Cross-Reference to Learning Outcomes: 5351.01, 5351.02, 5351.04, 5351.05, 5351.06, 5351.07, 5352.06, 5354.02, 5354.03, 5354.04, 5354.05, 5354.07

General Learning Outcome

Upon successful completion of the reportable subject, the apprentice is able to select and utilize rigging, hoisting , and lifting equipment according to regulatory and job requirements and in keeping with Safe Working Load guidelines.

Learning Outcomes

Upon successful completion, the apprentice is able to:

1.1 Demonstrate basic rope and knot work.

1.2 Select, wear and maintain personal protective equipment.

1.3 Identify basic rigging hardware.

1.4 Explain the applications for rigging hardware.

1.5 Explain how to ascertain Safe Working Loads of materials and equipment.

1.6 Explain the structure of wire rope and its applications.

1.7 Use appropriate tables to perform wire rope calculations.

1.8 Perform wire rope calculations using mathematical formulae.

1.9 Use international hand signals to communicate with others.

Instructional/Delivery Strategies:
Practical rigging sessions/lab.
Lecture.
Demonstrations.

Reference Materials:
Glerum, Jay O., *Stage Rigging Handbook*, Second Edition (Southern Illinois University Press) Carbondale Ill. 1997 ISBN: 0-8093-1744-3.

Minimum Equipment List:
Nylon, polyethylene, and hemp ropes.
Block and tackle, chain motor, and common rigging equipment.

Evaluation Structure	
Theory Testing	Application Exercises
50%	50%

Number:	2		
Title:	**Codes and Standards 2**		
Duration:	Total Hours: 24	Theory: 24	Practical: 0
Prerequisites:	Level 1 Reportable 2, Level 1 Reportable 5		
Co-requisites:	None		
Cross-Reference to Learning Outcomes: 5355.04, 5355.06, 5356.02, 5356.05, 5356.07, 5357.02, 5357.06, 5359.02, 5359.04			

General Learning Outcome

Upon successful completion of the reportable subject, the apprentice is able to demonstrate specific knowledge of the general rules of the Canadian Electrical Code (CEC), recognize differences in the Ontario Electrical Code (OEC), reference and use tables, diagrams, and appendices, and demonstrate familiarity with supplementary and amendatory sections as related to the entertainment industry.

Learning Outcomes

Upon successful completion, the apprentice is able to:

2.1 Interpret and apply General regulations of the Ontario Electrical Code found in sections 0, 2, 4, 6, 8, 10, 12, 14, 16, and 26.

- 2.1.1 Interpret definitions as per OEC section 0.
- 2.1.2 State ESA requirements regarding permits and inspection.
- 2.1.3 List requirements for working on electrical equipment.
- 2.1.4 Apply section 4 conductor rules to given load problems.
  - 2.1.4.1 Use tables to determine conductor requirements for known loads.
  - 2.1.4.2 Use derating factors to size conductor installations.
  - 2.1.4.3 Interpret tables for flexible cord ampacities.
- 2.1.5 Determine appropriate service sizes based on given demand loads.

2.1.6 Interpret demand factors and circuit loading.

2.1.6.1 Distinguish between continuous and non-continuous loads.

2.1.6.2 Select conductors and gear based on demand factors.

2.1.6.3 Explain the use of multiple derating factors.

2.1.6.4 Calculate conductor deratings and select appropriate sizes for given loads and conditions.

2.2 Explain section 26 regulations that are specific to the entertainment industry.

2.2.1 List requirements for outdoor installations.

2.2.2 Interpret rules pertaining to batteries.

2.2.3 Interpret regulations pertaining to arc lamps.

2.3 Apply information from diagrams and appendices as pertinent to the General Rules.

2.4 Distinguish and explain differences in supplementary or amendatory sections.

2.5 Identify sections of the code with reference to motion picture studio and theatre installation.

2.6 Identify code sections regarding amusement parks, midways, carnivals, and traveling shows.

2.7 Determine appropriate use of temporary wiring methods to entertainment applications.

2.8 Reference and interpret sections specific to lighting equipment.

Instructional/Delivery Strategies:
Lecture/discussion.
Case study projects.

Reference Materials:
Ontario Electrical Code.

Minimum Equipment List:
Standard classroom.

Evaluation Structure	
Theory Testing	Application Exercises
100%	0%

Number:	3		
Title:	**Electronics 1**		
Duration:	Total Hours: 21	Theory: 9	Practical: 12
Prerequisites:	Level 1 Reportable 5		
Co-requisites:	None		

Cross-Reference to Learning Outcomes: 5076.05, 5077.05, 5076.03, 5355.01, 5355.02

General Learning Outcome

Upon successful completion of the reportable subject, the apprentice is able to identify, layout, and connect resistors, light emitting diodes, transistors, logic gates, and opto-couplers in circuits according to drawing specifications, using circuit boards and bench tools to produce and troubleshoot component assemblies.

Learning Outcomes

Upon successful completion, the apprentice is able to:

3.1 Demonstrate the proper procedure for soldering and de-soldering.

3.2 Apply the standard resistor colour code.

3.3 List and describe the safety practices to be followed when measuring and testing circuits with test equipment.

3.4 Describe the theory of operation and the applications of multi-meters.

3.5 Define the term "ohm per volt" rating and describe meter loading.

3.6 Demonstrate the use of voltmeters, ammeters, ohmmeters and meggers in series, parallel, and combination circuits.

3.7 Connect resistors in series, parallel, and combination circuits, complete with voltmeter and ammeter connections.

3.8 State current and voltage requirements for silicon, germanium, and light emitting diodes (LED's).

3.9 Demonstrate requirements for silicon, germanium and LED's to be forward and reverse biased.

3.10 Describe and demonstrate how a transistor can be used as a switch.

3.11 Demonstrate the use of common TTL logic gates and their symbols to prove their truth tables.

3.12 Describe the operation of an opto-coupler.

3.13 State and demonstrate common applications for an opto-coupler.

Instructional/Delivery Strategies:
Demonstration/lecture.
Lab experiments and projects.

Reference Materials:
Herman, Stephen L. (2004). *Delmar's Standard Book of Electricity*. New York: Delmar. ISBN 1-4018-2565-6.

Minimum Equipment List:
Workbenches and chairs.
Regulated bench power supplies and multimeters.
Soldering equipment.
Breadboards, resistors and components.

Evaluation Structure	
Theory Testing	Application Exercises
25%	75%

Number:	4		
Title:	**Lighting Technology 1**		
Duration:	Total Hours: 24	Theory: 16	Practical: 8
Prerequisites:	Level 1 Reportable 4, Level 1 Reportable 5		
Co-requisites:	None		
Cross-Reference to Learning Outcomes: 5353.03, 5355.01, 5355.02, 5356.02, 5358.01, 5358.04, 5358.05, 5358.08			

General Learning Outcome

Upon successful completion of the reportable subject, the apprentice is able to specify luminaires for specific applications, and, using data sheets, describe the characteristics of their light output, describe their electrical characteristics, and calculate demand loads of lighting layouts.

Learning Outcomes

Upon successful completion, the apprentice is able to:

4.1 Describe properties of light in terms of unit quantities and measurements, including:

- 4.1.1 Color temperature.
- 4.1.2 Lumens.
- 4.1.3 Lux.
- 4.1.4 Candlepower.
- 4.1.5 Footcandles.
- 4.1.6 Wattage.

4.2 Identify and describe safety concerns and precautions related to light output, such as heat and ultraviolet radiation.

4.3 Identify lamps and sockets common to the industry.

4.4 Describe the characteristics and differences in operation of common industry lamps, such as HMI, Xenon, fluorescent, and incandescent.

4.5 Identify safety concerns in the handling, assembly and disassembly of luminaires, equipment, and bulbs.

4.6 List common luminaires used in typical applications, including:

4.6.1 Theatrical applications.

4.6.1.1 Describe the characteristics of lensed luminaires, such as:

- Blinders
- Border lights
- Ellipsoidal
- Fresnel
- Follow Spot
- Par can

4.6.1.2 Describe the characteristics of open-faced luminaires, such as:

- Beam Light
- Scoop
- Border light (with gel frames)
- Border lights– MR16
- Cyc lights:
- Cyc strip
- Sky Cyc
- Coda
- Iris
- Orion
- Scoop
- Foot lights
- Olivette

4.6.2 Film and studio applications.

4.6.2.1 Describe the characteristics of lensed luminaires, such as:

- Fresnel
- Ellipsoidal
- Par
- Cine Queen
- Mini Brute – 1,2,5,6, 9, 12 light
- Wendy Light - (196 lamp mini)
- Maxi Brute

4.6.2.2 Describe the characteristics of open-faced luminaires, such as:

- Blonde, or Mighty Mole
- Broad
- Cone
- China Hat [Vertical special scoop]
- Chicken coop
- Cyc light
- Far Cyc (Sky Cyc)
- Coda
- Iris
- Orion
- Pallas
- Scoop
- Skypan
- Fill
- MI Light
- Nook
- Redhead, or Mickey Mole
- Scoop
- Skypan
- Softlight
- Spacelight
- Sun Gun

4.7 List the similarities in luminaire use for theatrical, rock and roll, and live events.

4.8 Identify the characteristics and applications of automated luminaires, such as:

- Moving yoke
- Moving mirror
- Fixed FX lights

4.9 Determine usage of lighting accessories such as barn doors, shutters, iris, gobo holders, gels, and clamps.

4.10 Interpret a simple lighting plot and determine circuiting and current requirements for the layout.

Instructional/Delivery Strategies
Demonstration/lecture/participation.
Class exercises.

Reference Materials:
Shelly, Steven. A Practical Guide to Stage Lighting, Focal Press (an imprint of Butterworth-Heinemann) 1998, ISBN 0-240-80353.
Manufacturers' specifications.

Minimum Equipment List
Lighting lab/studio with distribution equipment, cables, and connectors.
Variety of common lighting luminaires, stands, and accessories.

Evaluation Structure	
Theory Testing	Application Exercises
75%	25%

Number:	5		
Title:	**Electrical Theory 2**		
Duration:	Total Hours: 33	Theory: 33	Practical: 0
Prerequisites:	Level 1 Reportable 5		
Co-requisites:	None		
Cross-Reference to Learning Outcomes: 5353.03, 5355.04, 5356.07, 5359.03			

General Learning Outcome

Upon successful completion of the reportable subject, the apprentice is able to : calculate circuit values for two and three wire distribution systems; describe the characteristics of primary and secondary cells; describe magnetic lines of force and list their characteristics; describe magnetic flux; solve problems associated with magnetic energy; explain Ohm's Law as applied to magnetic circuits; describe the relationship between magnetism and EMF; apply Fleming's hand rules and Lenz's law.

Learning Outcomes

Upon successful completion, the apprentice is able to:

5.1 List voltage characteristics of common distribution systems.

5.2 Use circuit diagrams to illustrate a common two-wire distribution.

- 5.2.1 Calculate circuit values based on given load demands.
- 5.2.2 Analyze current flow within the distribution.
- 5.2.3 Calculate power characteristics at various points within the distribution.

5.3 Use circuit diagrams to illustrate typical three-wire distributions.

- 5.3.1 Calculate circuit values based on given load demands.
- 5.3.2 Analyze current flow within the distribution.
- 5.3.3 Define the term "neutral",and indicate its significance in the circuit.
- 5.3.4 Calculate power characteristics at various points within the distribution.

5.4 Calculate power demands based on load characteristics and distribution type.

5.5 Use the International System of units (SI) to describe electrical quantities.

5.6 Use the American Wire Gauge (AWG) to describe conductor sizes.

5.7 Convert between AWG and metric units to describe conductor sizes.

5.8 Use the specific resistivity of a conductor to calculate line losses under prescribed load conditions.

5.9 Determine the effect of conductor temperature coefficients on circuit loading.

5.10 Describe the basic characteristics of common primary and secondary cells.

- 5.10.1 Describe common battery types and their applications.
- 5.10.2 Interpret battery ratings.
- 5.10.3 Calculate battery capacities based on Amp-Hour ratings.
- 5.10.4 State hazards associated with battery handling.
- 5.10.5 List safety concerns with charging and discharging of batteries.

5.11 State the fundamental law of magnetism.

5.12 Describe magnetic lines of force and list their characteristics.

5.13 Solve problems associated with magnetic energy.

5.14 Describe the relationship between magnetism and EMF.

5.15 State and apply Fleming's hand rules.

5.16 State and apply Lenz's law.

Instructional/Delivery Strategies:
Lecture.
Distributed Learning: paper-based; CD ROM; videos.

Reference Materials:
Herman, Stephen L. (2004). *Delmar's Standard Book of Electricity*. New York: Delmar. ISBN 1-4018-2565-6.

Minimum Equipment List:
Standard classroom.

Evaluation Structure	
Theory Testing	Application Exercises
100%	0%

Level 3

Reportable Subject Summary – Level 3

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
1.	Safety and Rigging 2	18	9	9
2.	Codes and Standards 3	24	24	0
3.	Electronics 2	21	12	9
4.	Lighting Technology 2	24	8	16
5.	Electrical Theory 3	33	33	0
	Total	**120**	**86**	**34**

Number:	1		
Title:	**Safety and Rigging 2**		
Duration:	Total Hours: 18	Theory: 9	Practical: 9
Prerequisites:	Level 1 Reportable 1		
Co-requisites:	None		

Cross-Reference to Learning Outcomes: 5351.01, 5351.02, 5351.04, 5351.05, 5351.06, 5351.07, 5352.06 5354.01, 5354.02, 5354.03, 5354.04, 5354.05, 5354.06, 5354.07, 5355.03

General Learning Outcome

Upon successful completion of the reportable subject, the apprentice is able to assess job conditions to select and safely use appropriate rigging, hoisting , and lifting equipment according to regulatory and job requirements.

Learning Outcomes

Upon successful completion, the apprentice is able to:

1.1 Demonstrate dead hanging and trimming skills.

1.2 Define a hemp line set.

1.3 Explain how a hemp line set works.

1.4 Identify and specify appropriate hardware and materials for various applications.

1.5 Demonstrate how to rig vertical, choker and bridle slings.

1.6 Demonstrate bridling, tripping and breasting techniques.

1.7 Diagram a block and tackle.

1.8 Reeve a block and tackle to minimize twisting.

1.9 Operate a block and tackle.

1.10 Explain the techniques of rigging with chain motors and trusses.

1.11 Specify materials and techniques for rigging points, and attaching motors and trusses.

1.12 Demonstrate the use of chain motors and trusses.

1.13 Explain the effects of loads and reactions related to physics of rigging.

1.14 Complete the calculations related to loads and reactions when preparing rigging.

1.15 Layout, specify, and safely rig projects to meet given criteria.

Instructional/Delivery Strategies:
Lecture/demonstration.
Lab exercises and projects.

Reference Materials:
Glerum, Jay O., *Stage Rigging Handbook*, Second Edition (Southern Illinois University Press) Carbondale Ill. 1997 ISBN: 0-8093-1744-3.

Minimal Equipment List:
Nylon, polyethylene, and hemp ropes.
Block and tackle, chain motor, and common rigging equipment.

Evaluation Structure	
Theory Testing	Application Exercises
50%	50%

Number:	2		
Title:	**Codes and Standards 3**		
Duration:	Total Hours: 24	Theory: 24	Practical: 0
Prerequisites:	Level 2 Reportable 2		
Co-requisites:	None		
Cross-Reference to Learning Outcomes: 5359.04, 5359.05, 5357.06, 5356.02, 5356.07, 5355.04, 5358.02, 5359.02			

General Learning Outcome

Upon successful completion of the reportable subject, the apprentice is able to interpret and apply OEC regulations to the installation of protection and control devices, Class 1 and Class 2 circuits, and installations specific to the entertainment industry.

Learning Outcomes

Upon successful completion, the apprentice is able to:

2.1 Identify and interpret Code regulations specific to protection and control.

- 2.1.1 Define the scope and general requirements of the section.
- 2.1.2 Define and differentiate between protective and control equipment.
- 2.1.3 Interpret regulations regarding the connection of equipment to devices.
- 2.1.4 List the requirements for protective devices in circuits.
- 2.1.5 Interpret and apply the “Tap” rule to given scenarios.
- 2.1.6 Explain Ground Fault Protection and relevant application.
- 2.1.7 Interpret regulations regarding fuse ratings and applications.
- 2.1.8 Interpret regulations regarding circuit breakers.
- 2.1.9 Interpret and apply control device regulations.

2.2 Identify and interpret Code regulations specific to Class 1and Class 2 installations.

- 2.2.1 Define the scope and general requirements of the section.
- 2.2.2 Define class 1 and 2 categories based on voltage, current, and application.
- 2.2.3 Describe applications suited for class 1 and 2 systems.
- 2.2.4 Describe different wiring methods permissible for class 1 and 2 systems.
- 2.2.5 Define the limitations of each type of system.
- 2.2.6 Explain the relationship of this section to other code sections.

2.3 Identify sections of the code with reference to theatre installations.

- 2.3.1 Explain the supplementary nature of this section.
- 2.3.2 Interpret and apply rules for fixed and portable switchboards.
- 2.3.3 Interpret and apply rules for fixed and portable equipment.

2.4 Identify code sections regarding amusement parks, midways, carnivals, film and TV sets, TV remote broadcasting locations, and traveling shows.

- 2.4.1 Interpret regulations as amendatory and supplementary to the general rules.
- 2.4.2 Define the scope and application of the section.
- 2.4.3 Apply grounding and bonding requirements specific to the section.
- 2.4.4 Interpret regulations regarding services and distribution.
- 2.4.5 Explain wiring methods specific to the section.
- 2.4.6 Interpret regulations specific to the use of single conductor cables.
- 2.4.7 Explain regulations pertaining to motor installations.

2.5 Identify code regulations pertaining to the installation of lighting equipment.

- 2.5.1 Interpret general requirements for lighting installations.
- 2.5.2 Use Installation rules to describe proper methods of setting up lighting.
- 2.5.3 Describe proper methods of wiring lighting equipment in various locations.
- 2.5.4 List requirements for lamp-holders.
- 2.5.5 Interpret criteria for the installation of systems of various voltages.
- 2.5.6 Use regulations to solve problems related to the layout and wiring of luminaires.

Instructional/Delivery Strategies:
Lecture/demonstration/discussion.

Reference Materials:
Ontario Electrical Code.

Minimal Equipment List:
Standard classroom.

Evaluation Structure	
Theory Testing	Application Exercises
100%	0%

Number:	3		
Title:	**Electronics 2**		
Duration:	Total Hours: 21	Theory: 12	Practical: 9
Prerequisites:	Level 2 Reportable 3		
Co-requisites:	None		
Cross-Reference to Learning Outcomes: 5355.01, 5356.02, 5358.07, 5359.04			

General Learning Outcome

Upon successful completion of the reportable subject, the apprentice is able to apply the principles of digital logic to practical applications used by computers, communications equipment, and control systems.

Learning Outcomes

Upon successful completion, the apprentice is able to:

3.1 Define the following logic functions: AND, OR, and NOT.

3.2 Deduce the truth tables, and draw the logic symbols for the AND, OR, NOT, NAND, NOR, and Exclusive OR/NOR gates.

3.3 Implement simple logic circuits using basic gates (AND, OR, NOT) which will function according to specifications described verbally or given by truth table.

3.4 Implement the exclusive OR function with basic gates.

3.5 Implement the AND OR functions using NAND and NOR gates.

3.6 Define the salient features of relays.

3.7 Draw normally open (N/O), normally closed (N/C), and transfer relay contact symbols used in the electrical industry.

3.8 Draw diagrams and assemble circuits using switches, lamps, and power supplies which perform the AND and OR functions.

3.9 Use ladder diagrams to illustrate logic and relay functions.

3.10 Define decimal, binary, octal, and hexadecimal number systems.

3.11 Define 1's and 2's complements.

3.12 Convert from one number system to another as follows:

3.12.1 Binary to decimal, and vice versa.

3.12.2 Binary to octal, and vice versa.

3.12.3 Binary to hexadecimal, and vice versa.

3.12.4 Decimal to hexadecimal and vice versa.

Instructional/Delivery Strategies:
Lecture/demonstration. Lab exercises and projects.

Reference Materials:
M. Birmingham, Logic 1, Humber College.

Minimal Equipment List:
Electronics lab with regulated power supplies, breadboards, components.

Evaluation Structure	
Theory Testing	Application Exercises
70%	30%

Number:	4		
Title:	**Lighting Technology 2**		
Duration:	Total Hours: 24	Theory: 8	Practical: 16
Prerequisites:	Level 2 Reportable 4		
Co-requisites:	None		

Cross-Reference to Learning Outcomes: 5355.05, 5356.02, 5352.07, 5352.09, 5356.05, 5358.03, 5358.04, 5358.05

General Learning Outcome

Upon successful completion of the reportable subject, the apprentice is able to perform inspections of lighting luminaires, describe their electrical characteristics, and install, connect, assemble and disassemble as required.

Learning Outcomes

Upon successful completion, the apprentice is able to:

4.1 Describe common lens systems.

4.2 Describe common reflectors.

4.3 Determine safe procedures for the testing of luminaires.

4.4 Determine appropriate maintenance procedures for luminaires.

4.5 Determine preproduction setup procedures for luminaires.

4.6 Demonstrate safe and proper luminaire and component handling.

4.7 Interpret a lighting plot to determine the scope of work.

- 4.7.1 Layout circuitry and determine load requirements.
- 4.7.2 Select cabling and distribution equipment for installation.
- 4.7.3 Work in teams to:
  - 4.7.3.1 Assemble distribution equipment.
  - 4.7.3.2 Connect circuit devices.
  - 4.7.3.3 Install luminaires.
  - 4.7.3.4 Connect power to main distribution.
  - 4.7.3.5 Adjust and focus luminaires.
  - 4.7.3.6 Disconnect and disassemble system.

Instructional/Delivery Strategies:
Lecture/demonstration.
Lab exercises and projects.

Reference Materials:
Shelly, Steven. A Practical Guide to Stage Lighting, Focal Press (an imprint of Butterworth-Heinemann) 1998, ISBN 0-240-80353.
Manufacturers' specifications.

Minimal Equipment List:
Lighting lab/studio with distribution equipment, cables, and connectors.
Variety of common lighting luminaires, stands, and accessories.

Evaluation Structure	
Theory Testing	Application Exercises
30%	70%

Number:	5		
Title:	**Electrical Theory 3**		
Duration:	Total Hours: 33	Theory: 33	Practical: 0
Prerequisites:	Level 2 Reportable 5		
Co-requisites:	None		
Cross-Reference to Learning Outcomes: 5352.02, 5352.03, 5352.04			

General Learning Outcome

Upon successful completion of the reportable subject, the apprentice is able to describe the characteristics and uses of common DC generators, describe the behaviour and perform calculations relating to applications of sinusoidal alternating current, single phase transformers and instrument transformers.

Learning Outcomes

Upon successful completion, the apprentice is able to:

5.1 List the types of common DC generators.

5.2 Describe the construction of a DC generator.

5.3 Describe the principles of operation of a DC generator.

- 5.3.1 Describe the characteristics of common types of DC generators.
- 5.3.2 Draw the schematics of common DC generators, showing connections for common applications.

5.4 Describe the characteristics of a sine wave.

- 5.4.1 Determine the frequency of a sine wave.
- 5.4.2 Calculate RMS value of the wave.
- 5.4.3 Calculate average value of the wave.
- 5.4.4 Calculate peak value of the wave.
- 5.4.5 Calculate instantaneous values of the wave.

5.5 Explain and calculate frequency, electrical and mechanical degrees.

5.6 Interpret and calculate phasors, vectors and vector diagrams.

5.7 Describe the effects of alternating voltage and current in a resistive device.

5.8 Describe the characteristics of a coil connected to an AC source.

5.9 Examine and calculate inductive reactance, voltage, current, and power of an inductive circuit.

5.10 Describe the characteristics of a capacitor connected to an AC source.

5.11 Examine and calculate capacitive reactance, voltage, current, power and phase relationships of a capacitive circuit.

5.12 Examine and calculate values for RL/RC/RLC series circuits.

5.13 Explain and calculate RL/RC parallel circuits.

5.14 Describe the principles of operation of various types of single phase transformers.

5.15 Determine and perform calculations involving turns/voltage/current ratios for single phase transformers.

5.16 Describe the characteristics of instrument transformers.

5.17 List applications for instrument transformers.

5.18 Explain the safety procedures for using instrument transformers.

Instructional/Delivery Strategies:
Lecture/demonstration.
Distributed Learning: paper-based; CD ROM; videos; demonstrations.

Reference Materials:
Delmar's Standard Book of Electricity, Delmar Publishers Inc., ISBN-0-8273-6849-6.
Optional:
Alternating Current Fundamentals, Delmar Publishers Inc. AC Circuits and Machines, Eugene Lister.

Minimal Equipment List:
Standard classroom.

Evaluation Structure	
Theory Testing	Application Exercises
100%	0%

Level 4

Reportable Subject Summary – Level 4

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
1.	Installation Methods	18	0	18
2.	Codes and Standards 4	24	24	0
3.	Control Systems	21	9	12
4.	Lighting Technology 3	24	8	16
5.	Electrical Theory 4	33	33	0
	Total	**120**	**74**	**46**

Number:	1		
Title:	**Installation Methods**		
Duration:	Total Hours: 18	Theory: 0	Practical: 18
Prerequisites:	Level 1 Reportable 4, Level 3 Reportable 5		
Co-requisites:	Level 4 Reportable 2		
Cross-Reference to Learning Outcomes: 5355.01, 5355.02, 5357.09			

General Learning Outcome

Upon successful completion of the reportable subject, the apprentice is able to connect and test rotating machines, examine the characteristics of different wiring configurations, and control both DC and AC motors with manual and magnetic starters.

Learning Outcomes

Upon successful completion, the apprentice is able to:

1.1 Identify the mechanical parts, windings and wiring connections of DC machines.

1.2 Demonstrate the connections of prime movers and generators for given outputs, including:

- 1.2.1 Series connections.
- 1.2.2 Shunt connections.
- 1.2.3 Over and under compounded connections.

1.3 Draw schematics and demonstrate wiring, starting, and control methods of series, shunt and compound DC motors.

1.4 Demonstrate methods for forward-reverse control of DC motors.

1.5 Identify the mechanical parts, windings, and wiring connections for single and three-phase squirrel cage induction motors.

1.6 Draw schematics and demonstrate manual and magnetic across-the-line starting techniques for single- and three-phase squirrel cage induction motors including:

- 1.6.1 Forward –reverse controls.
- 1.6.2 Stop – start – jog controls.
- 1.6.3 Multiple stop – start actuators.

Instructional/Delivery Strategies:
Lab exercises and projects.

Reference Materials:
Delmar's Standard Book of Electricity, Delmar Publishers Inc., ISBN-0-8273-6849-6.

Minimal Equipment List:
Motor lab with DC machines and various AC motors and controllers.

Evaluation Structure	
Theory Testing	Application Exercises
0%	100%

Number:	2		
Title:	**Codes and Standards 4**		
Duration:	Total Hours: 24	Theory: 24	Practical: 0
Prerequisites:	Level 3 Reportable 2		
Co-requisites:	None		
Cross-Reference to Learning Outcomes: 5355.03, 5355.045355.06, 5356.06, 5357.06			

General Learning Outcome

Upon successful completion of the reportable subject, the apprentice is able to interpret and apply OEC regulations specific to the installation of equipment in hazardous locations, and to the general installation methods for motors and generators.

Learning Outcomes

Upon successful completion, the apprentice is able to:

2.1 Identify OEC sections pertaining to hazardous locations.

- 2.1.1 Explain relevant applications of sections regarding hazardous locations.
- 2.1.2 Identify Tables relevant to these sections and their uses.
- 2.1.3 Identify Appendices relevant to installations in hazardous locations.
- 2.1.4 Use regulations, tables, and appendices to solve given installation problems.

2.2 Interpret Code regulations pertaining to motor installations.

- 2.2.1 Interpret special terminology used in this section of the Code.
- 2.2.2 Use regulations to determine appropriate wiring methods for motors and equipment.
  - 2.2.2.1 Describe considerations for the derating motor conductors.
  - 2.2.2.2 Identify and use tables to determine requirements for installations of different temperature and duty ratings.
  - 2.2.2.3 Explain the use of “tap rule” in motor installations.

2.2.2.4 Identify and differentiate between feeders and branch circuit conductors.

2.2.2.5 Use regulations to solve problems for the installation of conductors to equipment.

2.2.3 Explain the difference between overcurrent and overload protection.

2.2.4 Use regulations to determine overcurrent protection requirements for motors.

2.2.4.1 List acceptable overcurrent devices for motor installations.

2.2.4.2 Identify tables related to motor overcurrent installations.

2.2.4.3 Use regulations and related tables to correctly size overcurrent devices for individual motors.

2.2.4.4 Use regulations and tables to size overcurrent devices for feeders.

2.2.5 Use regulations to determine overload protection requirements for motors.

2.2.5.1 List acceptable types of overcurrent devices for motor installations.

2.2.5.2 Use rules and tables to determine number and location of overloads.

2.2.5.3 Define service factor as related to motors.

2.2.5.4 Use rules and tables to determine maximum overload ratings for motors with different service factors.

2.2.5.5 Determine the requirements for overheating protection of motors.

2.2.6 Interpret code rules to determine requirements for motor controls and disconnecting means.

2.3 Interpret Code regulations pertaining to the protection and control of generators.

- 2.3.1 List requirements for generator disconnects.
- 2.3.2 Use regulations to determine electrical protection requirements for generators.
- 2.3.3 State specific requirements for generators with balancer sets.

Instructional/Delivery Strategies:
Lecture/demonstration.
Class discussion and exercises.

Reference Materials:
Ontario Electrical Code.

Minimal Equipment List:
Standard classroom.

Evaluation Structure	
Theory Testing	Application Exercises
100%	0%

Number:	3		
Title:	**Control Systems**		
Duration:	Total Hours: 21	Theory: 9	Practical: 12
Prerequisites:	Level 3 Reportable 3		
Co-requisites:	None		
Cross-Reference to Learning Outcomes: 5355.01, 5355.025358.06, 5358.07			

General Learning Outcome

Upon successful completion of the reportable subject, the apprentice is able to plan, layout, and connect controller for automated lighting systems.

Learning Outcomes

Upon successful completion, the apprentice is able to:

3.1 Describe DMX-512 protocol and its applications.

3.2 Explain the principles of operation of a DMX controller.

3.3 Describe RS-485 architecture and connection methods of DMX devices.

3.4 Describe the pinouts of a 5-pin XLR connector.

3.5 Determine types of cable appropriate for use in DMX control.

3.6 State the capacity of a single DMX chain and its limitations.

3.7 Fabricate and test XLR cables.

3.8 Explain termination methods for a DMX daisychain.

3.9 Explain in, out, and thru connections on DMX devices.

3.10 Describe the concept of multiplexing.

3.11 Use XLR connectors to daisychain DMX devices for specified operation.

3.12 Demonstrate the ability to perform simple controls on DMX devices.

3.13 Plan and execute a control sequence using a DMX controller and devices.

Instructional/Delivery Strategies:
Lecture/demonstration.
Lab exercises and projects.

Reference Materials:
Online resources.
Lab/experiment package.

Minimal Equipment List:
DMX controller, DMX devices, cables, connectors, terminators.
Lab/shop environment with soldering and test equipment.

Evaluation Structure	
Theory Testing	Application Exercises
50%	50%

Number:	4		
Title:	**Lighting Technology 3**		
Duration:	Total Hours: 24	Theory: 8	Practical: 16
Prerequisites:	Level 3 Reportable 4		
Co-requisites:	None		
Cross-Reference to Learning Outcomes: 5358.02, 5358.05, 5358.06, 5358.07			

General Learning Outcome

Upon successful completion of the reportable subject, the apprentice is able to connect lighting equipment to control luminaires with manual and computerized controllers, to hang and trim instruments, and to verify the system.

Learning Outcomes

Upon successful completion, the apprentice is able to:

4.1 Demonstrate proper instrument hanging techniques.

4.2 Demonstrate proper focusing techniques.

4.3 Demonstrate proper instrument maintenance practices, including trimming of lighting instruments.

4.4 Identify common lighting equipment.

4.5 Demonstrate use of manual lighting board.

4.6 Demonstrate use of computerized lighting board.

4.7 Demonstrate an understanding of dimmers and circuit distribution.

4.8 Describe common lighting control protocols.

4.9 Connect and verify a working lighting control system.

Instructional/Delivery Strategies:
Lecture/demonstration.
Lab exercises and projects.

Reference Materials:
Shelly, Steven. *A Practical Guide to Stage Lighting*, Focal Press (an imprint of Butterworth-Heinemann) 1998, ISBN 0-240-80353.
Manufacturers' specifications.

Minimal Equipment List:
Lighting lab / studio with distribution equipment, cables, and connectors.
Manual and computerized lighting boards.
Variety of common lighting luminaires, stands, and accessories.

Evaluation Structure	
Theory Testing	Application Exercises
50%	50%

Number:	5		
Title:	**Electrical Theory 4**		
Duration:	Total Hours: 33	Theory: 33	Practical: 0
Prerequisites:	Level 3 Reportable 5		
Co-requisites:	None		
Cross-Reference to Learning Outcomes: 5303.03, 5355.04, 5357.0-09, 5359.03			

General Learning Outcome

Upon successful completion of the reportable subject, the apprentice is able to analyze three-phase electrical distributions, describe the operation of three-phase alternators, and explain the principles of operation of single and three-phase induction motors.

Learning Outcomes

Upon successful completion, the apprentice is able to:

5.1 List common single and three-phase distribution systems.

5.2 Use schematics and diagrams to represent distribution systems.

5.3 List the advantages and disadvantages of three phase and single phase circuits.

5.4 Differentiate between three phase Wye and Delta systems.

5.5 State the advantages and disadvantages of Wye and Delta systems.

5.6 Perform calculations for Wye and Delta systems.

- 5.6.1 Calculate voltages based on given loads.
- 5.6.2 Calculate current flow within a given system based on given loads.
- 5.6.3 Calculate system power requirements based on given loads.

5.7 Describe common applications for three phase transformers.

- 5.7.1 List the various types of three phase transformers and their construction.
- 5.7.2 Describe the methods employed to cool transformers.
- 5.7.3 Interpret transformer nameplate data.
- 5.7.4 Use nameplate data to perform load calculations.

5.7.5 Describe procedures for determining transformer polarity, terminal identification, impedance, winding ratio and insulation resistance.

5.7.6 Describe procedures for paralleling of transformers and taking one off line.

5.8 Explain the principles of three phase open delta connections.

5.9 Perform load calculations for open delta scenarios.

5.10 List applications for alternators.

5.10.1 Describe the construction of alternators.

5.10.2 List the differences and similarities between alternators and generators.

5.10.3 Interpret alternator nameplate data.

5.10.4 Use alternator nameplate data to calculate loading.

5.10.5 List the consequences of unbalanced loads on an alternator.

5.10.6 Describe methods used for the synchronizing of alternators.

5.10.7 List safety procedures and concerns when synchronizing alternators.

5.11 Use diagrams to explain alternator and transformer connections for various 3-phase systems.

5.12 Describe the principles of operation of AC induction motors.

5.12.1 Describe the construction of single-phase AC induction motors.

5.12.2 Describe the construction of three phase AC induction motors.

5.12.3 Describe the principle of operation of three phase AC induction motors.

5.12.4 Interpret nameplate data for single and three phase motors.

5.12.5 Perform calculations to determine power requirements of motors.

5.12.6 Perform calculations to size motors based on given load requirements.

Instructional/Delivery Strategies:
Lecture/demonstration.
Distributed Learning: paper-based; CD ROM; videos; demonstrations.

Reference Materials:
Delmar's Standard Book of Electricity, Delmar Publishers Inc., ISBN-0-8273-6849-6.

Optional:
Alternating Current Fundamentals, Delmar Publishers Inc. AC Circuits and Machines, Eugene Lister.

Minimal Equipment List:
Standard classroom.

Evaluation Structure	
Theory Testing	Application Exercises
100%	0%

APPENDIX A: Equipment List and Reference Materials

Level One

Reportable Subject	Equipment needed	Reference materials
1 Safe Working Practices	Step ladders, extension ladders, Fall arrest harnesses and equipment Sectional scaffolding and related platforms and accessories Personal Protective Equipment including hand and eye protection.	Occupational Health and Safety Act *Stage Rigging Handbook*, Second Edition (Southern Illinois University Press) Occupational Health and Safety Act
2 Codes and Standards 1	Classroom: tables and chairs	Ontario Electrical Code book Occupational Health and Safety Act ESA Spec 003
3 Communications	Networked multi-media computer lab with internet access.	Online help files, internet resources.
4 Shop Practices	Shop space with work benches, wiring booths, and open floor space. Common electrical distribution equipment and wiring materials. Common power and hand tools. Common hand-held meters or multimeters, such as amp-probe, voltage, and continuity testers.	Ontario Electrical Code ESA Spec 003
5 Electrical Theory 1	Standard classroom	Herman, Stephen L. (2004). *Delmar's Standard Book of Electricity*. New York: Delmar. ISBN 1-4018-2565-6

Level Two

Reportable Subject	Equipment needed	Reference materials
1 Safety and Rigging 1	nylon, polyethylene, and hemp ropes. Wire rope slings, hardware block and tackle, chain motor, and common rigging equipment.	Glerum, Jay O., *Stage Rigging Handbook*, Second Edition (Southern Illinois University Press) Carbondale Ill. 1997 ISBN: 0-8093-1744-3
2 Codes and Standards 2	Standard Classroom	Ontario Electrical Code
3 Electronics 1	Workbenches and chairs Regulated bench power supplies and multimeters Soldering equipment Breadboards, resistors and components	Herman, Stephen L. (2004). *Delmar's Standard Book of Electricity*. New York: Delmar. ISBN 1-4018-2565-6
4 Lighting Technology 1	Lighting lab/studio with distribution equipment, cables, and connectors. Variety of common lighting luminaires, stands, and accessories.	Shelly, Steven. *A Practical Guide to Stage Lighting*, Focal Press (an imprint of Butterworth-Heinemann) 1998, ISBN 0-240-80353 Manufacturers' specifications
5 Electrical Theory 2	Standard classroom	Herman, Stephen L. (2004). *Delmar's Standard Book of Electricity*. New York: Delmar. ISBN 1-4018-2565-6

Level Three

Reportable Subject	Equipment needed	Reference materials
1 Safety and Rigging 2	nylon, polyethylene, and hemp ropes. Block and tackle, chain motor, and common rigging equipment.	Glerum, Jay O., *Stage Rigging Handbook*, Second Edition (Southern Illinois University Press) Carbondale Ill. 1997 ISBN: 0-8093-1744-3
2 Codes and Standards 3	Classroom: tables and chairs	Ontario Electrical Code
3 Electronics 2	Electronics lab Regulated power supplies Breadboards, components	M. Birmingham, Logic 1, Humber College
4 Lighting Technology 2	Lighting lab/studio with distribution equipment, cables, and connectors. Variety of common lighting luminaires, stands, and accessories.	Shelly, Steven. *A Practical Guide to Stage Lighting*, Focal Press (an imprint of Butterworth-Heinemann) 1998, ISBN 0-240-80353 Manufacturers' specifications
5 Electrical Theory 3	Standard classroom	*Delmar's Standard Book of Electricity*, Delmar Publishers Inc., ISBN-0-8273-6849-6 Optional: *Alternating Current Fundamentals*, Delmar Publishers Inc. *AC Circuits and Machines*, Eugene Lister

Level Four

Reportable Subject	Equipment needed	Reference materials
1 Installation Methods	Motor lab DC machines AC motors and controllers	*Delmar's Standard Book of Electricity*, Delmar Publishers Inc., ISBN-0-8273-6849-6
2 Codes and Standards 4	Standard Classroom	Ontario Electrical Code
3 Control Systems	DMX controller, devices, cables, connectors, terminators. Lab / shop with soldering and test equipment	Online resources Lab/experiment package.
4 Lighting Technology 3	Lighting lab/studio with distribution equipment, cables, and connectors. Manual and computerized lighting boards Variety of common lighting luminaires, stands, and accessories.	Shelly, Steven. *A Practical Guide to Stage Lighting*, Focal Press (an imprint of Butterworth-Heinemann) 1998, ISBN 0-240-80353 Manufacturers' specifications
5 Electrical Theory 4	Standard classroom	*Delmar's Standard Book of Electricity*, Delmar Publishers Inc., ISBN-0-8273-6849-6 Optional: *Alternating Current Fundamentals*, Delmar Publishers Inc. *AC Circuits and Machines*, Eugene Lister

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