

Passaic County Technical Institute

Electrical Technology 2

March 6, 2008

Electrical Technology Level 2

I. Description

Electrical Technology Level 2 is a full year course. Which trains the students in the residential application of the Electrical Trades.

During the course, students are introduced to safety operations and procedures, basic electrical theory, hand tools, raceways conductors, and the vast options which are available to them in electrical trades.

The course is designed to give the students experience in job skills with hands on and basic theory assignments aligned with the core curriculum standards.

Upon completion of this course the students will be able to be employable as entry level apprentices in the electrical trades.

II. Objectives

1- Safety

- 1- Students will be able to match terms related to safety.
- 2- Students will be able to state shop safety rules.
- 3- Students will be able to state electrical safety rules.
- 4- Students will be able to state rules to follow when using hand tools.
- 5- Students will be able to state rules to follow when using power tools.
- 6- Students will be able to state electrical shock paths.
- 7- Students will be able to state major causes of hazards arising from electricity
- 8- Students will be able to discuss OSHA safety rules.
- 9- Students will be able to explain fire triangle theory.
- 10- Students will be able to practice safety for ladders.
- 11- Students will be able to arrange in order the steps to follow in case of an accident.
- 12- Students will be able to list in order the procedures used in electrical accidents.
- 13- Students will complete general shop safety test.

2. Hand tools

- 1- Students will be able to match terms associated with hand tools to their correct definition.
- 2- Students will be able to identify common tools used in the electrical industry.
- 3- Students will be able to match common hand tools to their use.
- 4- Students will be able to explain the rules for care of hand tools.
- 5- Students will be able to identify acceptable hand tools used in the electrical trade.

- 6- Students will be able to demonstrate proper use of hand tools when completing practical projects.

3. Electricity

- 1- Students will be able to list the fundamental properties of matter.
- 2- Students will be able to describe the structure of an atom.
- 3- Students will be able to explain the basic electrical concepts of current, voltage, resistance, and electrical polarity.
- 4- Students will be able to identify Ohm's Law theory.
- 5- Students will be able to complete calculations and equations related to Ohm's Law.
- 6- Students will be able to describe the characteristics of a series circuit.
- 7- Students will be able to describe the basic relationship of voltage, current and resistance in a series circuit.
- 8- Students will be able to explain the functions of a series circuit.
- 9- Students will be able to apply Ohm's Law Theory to a series circuit.
- 10- Students will be able to describe the characteristics of a parallel circuit.
- 11- Students will be able to describe the relationship of voltage, current and resistance in a parallel circuit.
- 12- Students will be able to explain the function of a parallel circuit.
- 14- Students will be able to apply Ohm's Law Theory to a parallel circuit.
- 15- Students will be able to describe the characteristics of a series-parallel circuit.
- 16- Students will be able to explain the functions of a series-parallel circuit.
- 17- Students will be able to demonstrate procedures for solving problems involving series-parallel circuits.
- 18- Students will be able to discuss the relationship of work to power.
- 19- Students will be able to explain the power and energy concepts to practical problems.

4. Electrical symbols and devices

- 1- Students will be able to identify symbols used in the electrical trade.
- 2- Students will be able to identify enclosures used in the electrical trade.
- 3- Students will be able to explain use of boxes used in the electrical trade.
- 4- Students will be able to identify switches and receptacles used in the electrical trade.
- 5- Students will be able to demonstrate the use of boxes, switches and receptacle used in the electrical trade.
- 6- Students will be able to size conductors for general wiring.
- 7- Students will be able to state locations of switches and receptacles in dwellings.
- 8- Students will be able to identify UL listing of electrical equipment.
- 9- Students will be able to select the correct boxes for applications needed.

5. National Electrical Code

- 1- Students will be able to match to their correct functions abbreviations of standards organizations associated with the National Electric Code.
- 2- Students will be able to match items associated with the National Electric Code to their correct definitions.
- 3- Students will state the purpose of the code.
- 4- Students will list factors that the code is not intended to the course.

- 5- Students will state the intent of the code regarding mandatory enforcement.
- 6- Students will match code chapter numbers to their correct areas of application.
- 7- Students will discuss in order the steps in finding information in the code.
- 8- Students will explain the code introduction and first chapter.
- 9- Students will explain the code index.
- 10- Students will find information in the code.

6. Determining the required number and location of lighting and small appliance circuits.

- 1- Students will be able to explain the basics of sizing wires to specific loads.
- 2- Students will be able to determine proper voltage for electrical applications.
- 3- Students will be able to calculate floor areas of dwelling.
- 4- Students will be able to determine minimum number of Lighting branch circuit.
- 5- Students will be able to determine the number of small appliance branch circuits.
- 6- Students will be able to determine locations of switches and receptacles in a residence.

7. Conductor sizes and types, wiring methods, wire connections, Voltage drops, and neutral sizing.

- 1- Students will be able to explain use of type NM (romex) and AC(armored cable) in residential wiring.
- 2- Students will be able to size conductors for use.
- 3- Students will be able to practice rough wiring applications.
- 4- Students will be able to explain raceways used in residential wiring.
- 5- Students will be able to explain the uses of service cable.

8. Switch control of lighting circuits, and receptacle bonding

- 1- Students will be able to identify grounded and ungrounded conductors in cables.
- 2- Students will be able to identify various types of toggle switches.
- 3- Students will be able to select switches for proper current rating.
- 4- Students will be able to explain 3 way switching.
- 5- Students will be able to explain various ways of bonding devices.

9. Ground fault circuit interrupters, voltage surges, isolated

- 1- Students will be able to explain the operation of GFI devices.
- 2- Students will be able to explain GFI connections.
- 3- Students will be able to explain GFI requirements.
- 4- Students will be able to practice proper gfi applications.
- 5- Students will be able to explain voltage surge theory.
- 6- Students will be able to discuss surge suppression theory.

10. Light fixtures, ballasts, lamps

- 1- Students will be able to understand fixture types and requirements.
- 2- Students will be able to connect recessed fixtures, ceiling mounted fixtures and wall mounted fixtures.
- 3- Students will be able to explain ballast wiring.
- 4- Students will be able to explain thermal rating of light fixtures.
- 5- Students will be able to explain UL listing of fixtures.

11. Lighting and branch circuits for bedrooms

- 1- Students will be able to explain the factors that influence the grouping of outlets into circuits.
- 2- Students will be able to estimate loads for outlet circuits.
- 3- Students will be able to draw receptacle layouts for room.
- 4- Students will be able to explain closet lighting requirements.
- 5- Students will be able to explain bedroom lighting layouts.

12. Lighting and branch circuits for bathrooms and halls

- 1- Students will be able to explain GFI receptacle layout for bathrooms.
- 2- Students will be able to explain lighting layouts for bathrooms.
- 3- Students will be able to explain exhaust fan installation for bathrooms.
- 4- Students will be able to explain receptacle requirements for hallways.
- 5- Students will be able to explain lighting requirements for hallways.

13. Lighting and branch circuits for entry and porches

- 1- Students will be able to explain lighting locations for foyer entries.
2. Students will be able to explain exterior locations for porch lighting.
3. Students will be able to practice installation of foyer and exterior fixtures.

14. Lighting and branch circuits and small appliance circuits for kitchens

- 1- Students will be able to explain the features and installation of a kitchen exhaust fans.
- 2- Students will be able to explain code requirements for small appliance circuits in kitchen.
- 3- Students will be able to explain grounding of kitchen equipment.
- 6- Students will be able to explain multi wire circuits.
- 7- Students will be able to calculate lighting loads in kitchens.
- 8- Students will be able to explain kitchen lighting layouts.

15. Lighting and branch circuits for living rooms

- 1- Students will be able to explain receptacle requirements for living rooms.
- 2- Students will be able to explain various types of lighting in living rooms.
- 3- Students will be able to install dimmers for lighting.

16. Lighting and branch circuits for dining room

- 1- Students will be able to explain receptacle requirements for dining rooms.
- 2- Students will be able to explain branch circuits for dining room.
- 3- Students will be able to explain various types of lighting for dining rooms.

17. Laundry room circuit

- 1- Students will be able to explain receptacle requirements for laundry room.
- 2- Students will be able to explain electric dryer hook up.
- 3- Students will be able to explain lighting layout for laundry room

18. Lighting and branch circuits for garage

- 1- Students will be able to understand the fundamentals of providing proper lighting in residential garages.
- 2- Students will be able to understand the application of GFI protection for receptacles in residential garages.
- 3- Students will be able to complete garage circuit diagrams.
- 4- Students will be able to make a proper installation for a residential overhead garage door opener.

19. Lighting Branch-Circuit and Receptacle Circuits for the Basements

- 1- Students will be able to understand GFI receptacles requirements for basements.
- 2- Students will be able to explain lighting requirements for basements.
- 3- Students will be able to explain proper installation for surface mounted boxes.

20. Special-Purpose Outlets-Water Pump and Water Heater

- 1- Students will be able to list the requirements for deep-well jet pump and submersible pump installations.
- 2- Students will be able to calculate the conductor size, conduit size, and over current protection required for pump circuits.
- 3- Students will be able to list some of the electrical circuits used for connecting and metering electric water heaters.
- 4- Students will be able to describe the basic operation of water heaters.
- 5- Students will be able to make proper electrical and grounding connections for water heaters, water pumps, and metal casings.

21. Special-Purpose Outlets for Ranges, Counter-Mounted Cooking Unit, and Wall-Mounted Oven

- 1- Students will be able to understand NEC requirements for electric appliances.
- 2- Students will be able to identify and understand the purpose of the National Electrical Manufacturers Association.
- 3- Students will be able to understand when to use 3-wire and 4-wire receptacles and cords for electric range hookups.
- 4- Students will be able to compute loads and select proper conductor sizes for electric ranges, wall-mounted ovens, and counter-mounted cooking unit.
- 5- Students will be able to supply counter-mounted cooking units and wall-mounted ovens by connecting them to one feeder using the tap rule.
- 6- Students will be able to understand how to install a feeder to a load center; then divide the feeder to individual circuits to supply the appliances.

22- Special purpose outlets food waste disposer and dishwashers

- 1- Students will be able to install circuits for kitchen appliances such as food disposers and a dishwasher.
- 2- Students will be able to determine the maximum power demand for disposals and dishwashers.
- 3- Students will be able to describe disconnecting means for kitchen appliances.
- 4- Students will be able to make proper grounding connections to the appliances.

23- Special purpose outlets electric heating and air conditioning

- 1- Students will be able to list the advantages of electric heating.
- 2- Students will be able to describe the components and operation of electric heating systems.
- 3- Students will be able to describe thermostat control systems for electric heating systems.
- 4- Students will be able to install electric heaters with appropriate temperature control according to NEC rules.
- 5- Students will be able to discuss air conditioners, heat pumps, terminology, code requirements, and electrical connections.
- 6- Students will be able to explain how heating and cooling may be connected to the same circuit.
- 7- Students will be able to understand where to mount the disconnect switch outdoors for air conditioners and heat pumps.

24- Gas and Oil Central Heating Systems

- 1- Students will be able to understand the basics of typical home heating systems.
- 2- Students will be able to understand some of the more important components of typical
- 3- home heating systems.
- 4- Students will be able to interpret basic schematic wiring diagrams.
- 5- Students will be able to understand how a thermocouple and thermopile operate.
- 6- Students will be able to understand and apply the Code requirements for control-circuit wiring, Article 725,NEC.

25- Television, Telephone, and Low-Voltage Signal Systems

- 1- Students will be able to install television outlets, antennas, cables, and lead-in wires.
- 2- Students will be able to list CATV installation requirements.
- 3- Students will be able to describe the basic operation of satellite antennas.
- 4- Students will be able to install telephone conductors, outlets boxes, and outlets.
- 5- Students will be able to define what is meant by a signal circuit.
- 6- Students will be able to describe the operation of a two-tone chime and a four-note chime.
- 7- Students will be able to install a chime circuit with one main chime and one or more extension chimes.

26- Heat, Smoke, Carbon Monoxide Detectors, Fire Alarms, and Security Systems.

- 1- Students will be able to understand the National Fire Protection Association Standard No. 72, which is the National Fire Alarm Code.
- 2- Students will be able to name the two basic types of smoke detectors.
- 3- Students will be able to discuss the location requirements for the installation of heat and smoke detectors for minimum acceptable level of protection.
- 4- Students will be able to discuss the location requirements for the installation of heat and smoke detectors for increased protection that exceed the minimum acceptable levels of protection.
- 5- Students will be able to list the major components of typical residential smoke, heat, and security systems.

- 6- Students will be able to discuss general NEC requirements for the installation of residential smoke, heat, and security systems.
- 7- Students will be able to understand the basics of carbon monoxide detectors.

27- Remote-Control Systems Low-Voltage

- 1- Students will be able to explain the operation of a low-voltage, remote control system for lighting circuits.
- 2- Students will be able to interpret the wiring diagrams of various types of low-voltage, remote control systems.
- 3- Students will be able to install a low-voltage, remote control system to comply with the requirements of the NEC.

28- Service-Entrance Equipment

- 1- Students will be able to determine the total calculated load of the residence.
- 2- Students will be able to calculate the size of the service entrance, including the size of the neutral conductors.
- 3- Students will be able to understand the code requirements for services, Article 230.
- 4- Students will be able to understand how to read a watt-hour meter.
- 5- Students will be able to fully understand special code rules for single-family dwelling service entrance conductor sizing.
- 6- Students will be able to de-rate service entrance conductor if installation is located in extremely hot climate.
- 7- Students will be able to do an optional calculation for computing the required size of service entrance conductors for residence.

29- Service- Entrance Calculations

- 1- Students will be able to define electrical service, overhead service, service drops, and underground service.
- 2- Students will be able to list the various code sections covering the installation of mast-type overhead service and underground service.
- 3- Students will be able to discuss the code requirements for disconnecting the electrical service using a main panel and load centers.
- 4- Students will be able to discuss the grounding of interior ac systems and the bonding of all service entrance equipment.
- 5- Students will be able to describe the various types of fuses
- 6- Students will be able to select the proper fuse for particular installation.
- 7- Students will be able to explain the operation of fuses and circuit breakers.
- 8- Students will be able to explain the term interrupting rating.

30- Swimming Pools, Spas, and Hot Tubs

- 1- Students will be able to recognize the importance of proper swimming pool wiring with regard to human safety.
- 2- Students will be able to discuss the hazards of electrical shock associated with faulty wiring in, on, or near pools.
- 3- Students will be able to describe the difference between permanently installed pools and pools that are portable.

4- Students will be to understand and apply the basic Code requirements for the wiring of swimming pools, spas, hot tubs, and hydro massage tubs.

31- Blueprint reading and design

- 1- Students will be able to draw symbols related to blueprints.
- 2- Students will be able to match terms related to blue prints.
- 3- Students will be able to explain measurement fundamental of blueprints.
- 4- Students will be able to identify numbers of conductors in conduits as is indicated by the blueprint.
- 5- Students will be able to take off information and place it on a take off sheet.
- 6- Students will be able to relate blueprints to code.
- 7- Students will be able to design model blueprints.

OUTLINE OF COURSE

Safety

Hand tools

Electricity

Electrical symbols and outlets

National Electrical Code

Determining the required number and location of lighting and small appliance circuits.

Conductor Sizes and Types, Wiring Methods, Wire Connections, Voltage Drops, Neutral Sizing.

Switch Control of Lighting Circuits, Receptacle Bonding,

Ground Fault Circuit Interrupters, Voltage Surges, Isolated Ground.

Lighting Fixtures, Ballasts, and Lamps

Lighting Branch-Circuit for Bedroom

Lighting Branch-Circuit for Bathrooms and Hallways

Lighting Branch-Circuit for Front Entry and Porch

Lighting Branch-Circuit and Small Appliance Circuits for Kitchen

Lighting Branch-Circuit for Living Room

Lighting and Branch Circuit for Dining Room

Laundry Room Circuit

Lighting Branch-Circuit for Garage

Lighting Branch-Circuit and Receptacle Circuits for the Basement

Special-Purpose Outlets-Water Pump and Water Heater

Special-Purpose Outlets for Ranges, Counter-Mounted Cooking Unit, and Wall-Mounted Oven

Special-Purpose Outlets-Food Waste Disposer and Dishwasher

Special-Purpose Outlets-Electric Heating and Air Conditioning

Gas and Oil Central Heating Systems

Television, Telephone, and Low-Voltage Signal Systems

Heat, Smoke, and Carbon Monoxide Detectors, Fire Alarms, Security Systems

Remote-Control Systems-Low Voltage

Service-Entrance Equipment
Service-Entrance Calculations
Swimming Pools, Spas, and Hot Tubs
Blueprint Reading and Design

III. Text books and Instructional Materials.

Electrical Wiring Residential -

Ray C. Mullin

15th Edition

Delmar Publishers, 2006

Electrical Raceways and Other Wiring Methods

Richard E. Loyd

5rd Edition

Delmar Publishers, 2006

National Electrical Code

National Fire and Protection Association Inc., 2008

Electrical Grounding

Ronald P. O'Riley

7th Edition

Delmar Publishers, 2006

I V. Teaching Strategies

Various teaching methods are utilized in this course. Meaningful instruction will be given using workbooks, textbooks, handouts, and hands on practical projects. Teacher modeling of lecture on both practical and written work will be implemented and evaluated. The use of specific audiovisual materials will supplement classroom instruction.

VI. Evaluation and Proficiencies

A. Evaluation

Students will be evaluated using the following criteria:

1. Class participation
2. Attendance
3. Tests

4. Quizzes
5. Practical projects
6. Note books

B. Proficiencies

Upon successful completion of the requirements of this course, the students will be able to:

- 1- Understand safety procedures for electrical field.
- 2- Understand the basic functions of electricity.
- 3- Identify common hazards found on construction sites. (ccwr 5.6)
- 4- Establishing OSHA and customer safety requirements. (nssb)
- 5- Students will understand how technology systems function. (ccwr2.1)
- 6- Identify hand tools used in Electrical Trades
- 7- Recognize and define a problem, or clarify decisions to be made (ccwr 3.1)
- 8- Monitor and evaluate their own thinking). (ccwr 3.10)
- 9- Identify and evaluate thir own thinking.(ccwr 3.9)
- 10- Set long and short term goals. (ccwr4.1)
- 11- Use time efficiently and effectively. (ccwr 4.9)
- 12- Work cooperatively with others to accomplish a task. (ccwr 4.2)
- 13- Describe constructive responses to criticism. (ccwr 4.4)
- 14- Understand the purpose and codes in the National Electrical Code.
- 15- Understand the purpose of the American Wire Gauge.
- 16- Identify raceways used in the Electrical Trade.
- 17- Determine sizes of Branch Circuits.
- 18- Practice wiring of Switches, Receptacles and, Light Fixtures.
- 19- Design wiring layouts for rooms in house.
- 20- Understand wiring and codes for appliances.
- 21- Practice wiring of service entrances.
- 22- Calculate service entrance sizes.
- 23- Identify types of over current protection.
- 24- Identify proper enclosures used in electrical trade.
- 25- Understand proper wiring of pools and spas.
- 26- Understand blue print reading and design.
- 27- Communicate mathematically through written, oral, symbolic, and visual forms of expressions, (M4.2)
- 28- Understand , select and apply various methods of performing numerical operations. (m4.8)
- 29- Use a variety of estimation strategies and recognize situations in which estimation is appropriate. (m 4.10)
- 30- Speack for a variety of real purposes and audiences. (lal 3.1)
- 31- Read a variety of materials and texts with a comprehension and critical analysis. (lal 3.4)
- 32- Understand and use nontextual visual information. (lal3.5)
- 33- Learn to identify systems of interacting components and understand how their interactions combine to produce the overall behavior of the system. (s 5.1)
- 34- Develop an understanding of technology as an application of scientcific principles. (s5.4)

- 35- Develop an understanding of the environment as a system of interdependent components affected by human activity and natural phenomena. (s 5.12)
- 36- Plan and initiate projects on a daily and weekly basis. (nssb I)
- 37- Planning and installing raceway projects (nssb VI)
- 38- Installing services to buildings and other structures. (nssb IV)
- 39- Installing wiring to repair old work. (nssb VII)
- 40- Installing receptacles, lighting systems and fixtures. (nssb IX)
- 41- Troubleshooting and repairing electrical systems. (nssb X)

Key I = Introduced
 D = Developed in Depth
 R = Reinforced

Electrical Technology II

SCOPE AND SEQUENCE CHART

Suggested Grade Levels

SKILL TO BE LEARNED	9	10	11	12
Understand safety procedures for electrical field		D		
Understand the basic functions of electricity		D		
Identify hand tools used in electrical trades		D		
Understand the purpose and codes in the NEC		D		
Understand the purpose of the AWG		D		
Identify raceways used in the electrical trade		D		
Determine sizes of branch circuits		D		
Practice wiring of switches, receptacles and light fixtures		D		
Design wiring layouts for rooms in house		D		
Understand wiring and codes for appliances		D		
Practice wiring of service entrances		D		
Calculate service entrance sizes		D		
Identify types of over current protection		D		
Identify proper enclosures used electrical trade		D		
Understand proper wiring of pools and spas		D		
Understand blue print reading and design		D		

Electrical Technology Level 2

STUDENT HANDOUT

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- 37- Planning and installing raceway projects
- 38- Installing services to buildings and other structures.
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- 40- Installing receptacles, lighting systems and fixtures.
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