

# Lineman Program Catalog

## Power Line Job Training & Safety Program

Distribution  
& Transmission



**MjTS**

**MERCHANT**  
Job Training & Safety

# MJTS Program Overview

Merchant's Powerline Job Training & Safety Program is a distance-learning curriculum tailor-made for entry-level electric utility personnel. The program most commonly serves as related technical instruction for use in an apprenticeship program leading to journeyman certification when coupled with structured on-the-job training. It exceeds the U.S. Department of Labor's Office of Apprenticeship minimum requirement of 144 hours of related instruction per year. The program is also well suited for skill advancement of experienced employees with duties ranging from line personnel through management.

The Merchant Program is a four-year curriculum with a modular construction. Beginning at day one, MJTS core curriculum provides your employees with the practical key competencies critical to their on-the-job productivity and safety. The material is organized into blocks of information and presented in manageable units of instruction. The Merchant program is comprised of nineteen blocks.

Block 1	The Electric System	Block 11	Power Use
Block 2	Basic Electricity	Block 12	Watt-Hour Meters
Block 3	Math	Block 13	Test Meters
Block 4	Safety	Block 14	Street Lighting
Block 5	Staking/Mapping	Block 15	Orientation
Block 6	Rigging	Block 16	Underground Distribution
Block 7	Transformers	Block 17	Substations
Block 8	Overvoltage/Overcurrent Protective Devices	Block 18	Equipment Safety
Block 9	Live Line Maintenance	Block 19	Equipment
Block 10	Voltage Regulation		

Each workbook is illustrated extensively with photographs and graphics to enhance the readability and understanding of technical material. Supplemental multimedia and video is available via our web site free of charge. If questions arise, trainees can contact our office 5 days a week by phone, e-mail, or fax during normal business hours (Monday - Friday, 8 AM - 5 PM CST).

## Advantages of the MJTS Program

### Individualized Learning

Design of the instructional material ensures that any trainee can successfully complete the program by self-study. Basic Concepts are presented for those who need remedial review, while others can accelerate through those materials quickly before moving on to the more advanced concepts. Your trainees have unlimited access to qualified instructors at MJTS who can accurately answer any questions that arise.

### Proven Learning Methods

Dennis Merchant, an expert with the material who had many years of experience in the field and as a curriculum writer and teacher, designed the course content. MJTS presents the material to your employees using a time-tested format for vocational education. Since 1983 we have successfully helped advance and strengthen the careers of many thousands of trainees.

### No Scheduling Problems

Distance learning is an ideal component of an apprenticeship program. The course is structured for self directed study. Your employees can study when its convenient for them. Training is portable, flexible, and cost effective. Your Employee's travel expenses and time off the job for training are eliminated.

### Certifiable/Mastery Oriented

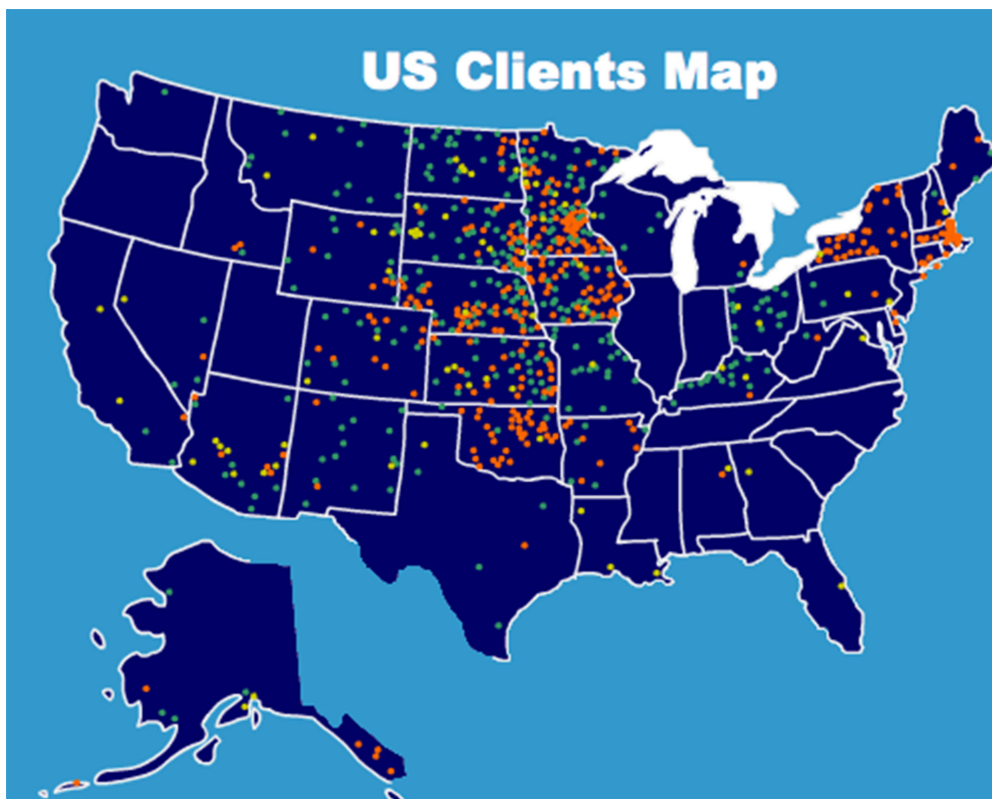
The training is consistent, measurable, and accountable for each of your trainees. They must demonstrate mastery in order to complete each section of the course. Our program exceeds the yearly 144 hours of related instruction required by the US Office of Apprenticeship, so your employees can earn national certification.

### Permanent Records

Your employee's training records are permanently retained at our office. Employers can request records free of charge at any time.

### Centralized Control

Individualized study can be implemented at multiple locations, with all of your employees receiving the same quality instruction. Yet, centralized administrative control is maintained through our office. We summarize each employee's progress and mail them to your training coordinator each month.



# Program Implementation

## Training Coordinators

One or more employees at your company is appointed Training Coordinator. Training Coordinators are the main point of contact for your company with Merchant Job Training and Safety. This person faxes or e-mails Trainee applications to MJTS, receives workbooks and other required textbooks, distributes them to Trainees, has possession and control of tests, schedules test times for the Trainees, and receives grade reports and billing statements from MJTS. The Training Coordinator proctors the tests, administering them by "Closed Book," and then faxes them to MJTS for grading and recording of scores into the Trainee's permanent record. Commonly, employees appointed to be coordinators are crew leaders, safety/training staff, administrative staff, or superintendents.

## Trainees

Each workbook contains nine sections, most sections having four units of instruction. Trainees study the material and complete assignment sheets at the end of each unit, checking their answers in the back of the workbook. Trainees take a section test when they are ready, or on a schedule set by their training coordinator. The rate at which a trainee progresses through the material is completely at the discretion of the trainee and his employer. However, the program is designed so that one workbook is completed per calendar year. After successfully completing all nine sections, trainees take a final exam that covers material from the entire year. After completing the fourth year workbook, trainees take a comprehensive final exam that covers material from the entire four years.

MJTS encourages trainees to ask questions of journeyman linemen and other experienced personnel in their company. We also encourage them to contact our office any time with questions or comments.

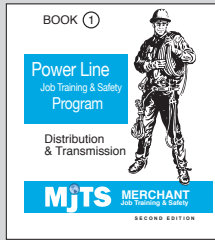
MJTS sets a minimum passing test score of 70%. Trainees who fail a test may retake an alternate test after reviewing and studying the material that they have missed. The original score and the retest are averaged. Trainees who fail a test are especially encouraged to contact our office for help.

## Merchant Job Training and Safety

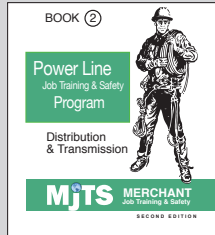
MJTS grades trainee tests and returns the results to the training coordinator, normally within minutes of receiving them. MJTS comments on all material or questions submitted by the Trainee and/or Training Coordinator, and issues certification of successful completion of the program.

## Optional Fifth Year

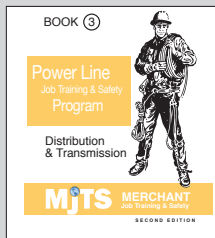
MJTS offers an optional fifth year that companies can use for continuing education. It is not part of the main program, but is implemented using the same procedures. The subject matter builds upon the first four years. Several companies require their journeyman linemen to complete the optional fifth year, and many graduates of our program register for the fifth year on their own. MJTS recommends that enrollees in the fifth year have achieved at least an 85% on the main program's fourth year final exam.



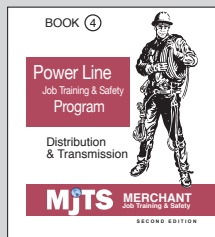
9 Section Tests  
1st Year Final



9 Section Tests  
2nd Year Final



9 Section Tests  
3rd Year Final



9 Section Tests  
4th Year Final



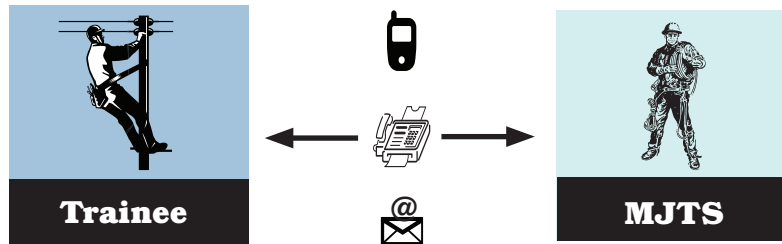
MJTS Certificate  
Issued  
at Completion



US Department of Labor  
Certificate issued for Registered  
Apprenticeship

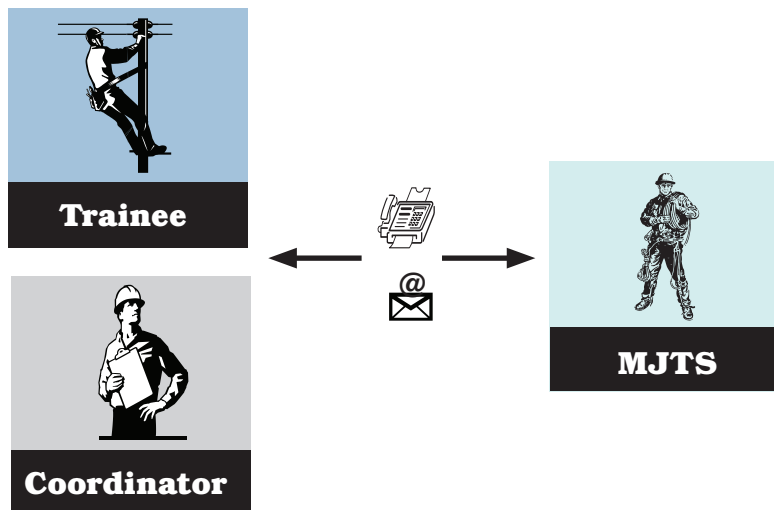
## Trainees Study Material - One Unit at a Time

Trainees study units in a section. They complete assignment Sheets and check their answers with those in the answer key. If they have trouble they are encouraged to contact our office by phone, fax, or by e-mail. They can also find help at <http://mjts.com>.



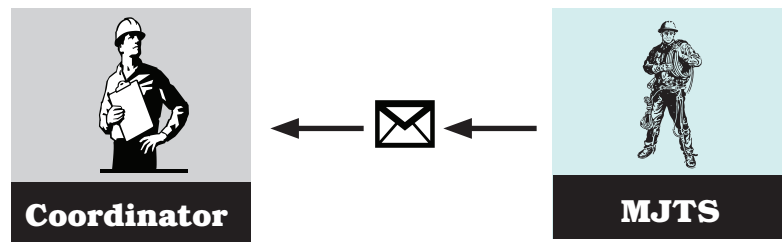
## Coordinator Proctors Test by Closed Book Method

Training coordinators and trainees schedule a mutually agreeable test time. Trainees complete their tests by close book method and transfer their answers on to fax forms that MJTS provides as part of the test kit. When trainees finish, their coordinator faxes the test to MJTS for grading. MJTS maintains several fax lines to assure a clear line when transmitting. Test results are faxed back to the training coordinator by MJTS staff, normally within minutes of receiving them.



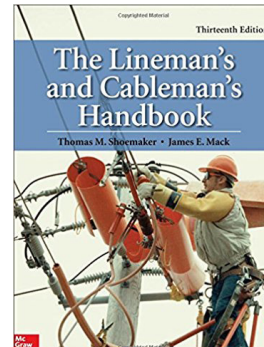
## Coordinator Receives Grade Reports Monthly

At the first of each month, MJTS mails a grade report to the training coordinator, keeping them apprised of trainee progress. MJTS faxes or e-mails grade reports at any time to coordinators who request them. They can request reports by phone or by e-mail.



# Required Textbooks

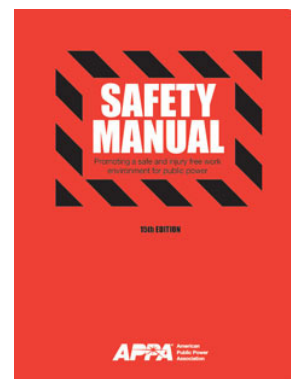
**Lineman's & Cablemen's Handbook - 13th ed**  
by Shoemaker



**First Aid/CPR/AED Participant's Manual**  
The American Red Cross



**APPA Safety Manual/OSHA Standards**  
**16th ed**  
American Public Power Association



# Streaming assistance over the internet from YouTube

*We have videos on YouTube to supplement the workbooks on many of the most difficult topics. They are organized by year and topic into playlists to make them easy to find.*

*To access the videos go to:*

[www.youtube.com/merchanttjts](http://www.youtube.com/merchanttjts)

*Click on "Playlists."*

The screenshot displays the YouTube channel page for 'Merchant Job Training and Safety'. The channel banner features an image of workers on a lift. The page is organized into several sections:

- What to watch next:** A video titled 'Eye Splice Double Braid Rope' by merchanttjts, with 175 views.
- Recent activity:** A list of recent uploads, including 'Hubbell Power Systems Videos' (added 5 days ago), '1st Year Introduction to the Electric System' (added 5 days ago), and '1st Year Basic Electricity' (added 5 days ago).
- Popular uploads:** A row of four videos: 'Practice Transformer Connection P#1, Wye Delta' (3,537 views, 10 months ago), 'Introduction to Three Phase Systems' (2,706 views, 11 months ago), 'Vector Diagraming Transformer Connections' (2,615 views, 11 months ago), and 'Ferroresonance' (1,887 views, 10 months ago).
- Playlists:** A row of four playlists: '1st Year Introduction to the Electric System' (9 videos, 6 days ago), '1st Year Basic Electricity' (6 videos, 6 days ago), '1st Year Electrical Math' (11 videos, 6 days ago), and '1st Year Rigging' (12 videos, 6 days ago).

A red arrow points from the left side of the page towards the 'Playlists' section. The bottom of the page shows the YouTube footer with navigation links for About, Press & Blogs, Copyright, Creators & Partners, Advertising, and Developers.

# Policies

## Enrollment

- Trainees must be employed by a rural electric, municipal, contractor, or private utility.
- Trainees must be at least 18 years of age.
- Trainees must be high school graduates or they must possess a GED.

## Testing for Advanced Placement

Employers transitioning trainees from other apprentice classroom related training programs, or new hires coming from companies who utilize other training programs often wish to begin the Merchant Program with advanced placement. OSHA requires that employers ensure employee training. Accordingly, decisions related to employee training ultimately belong to the employer, with one caveat. Employers with registered apprenticeships should contact their state Office of Apprenticeship to verify that allowing advanced placement does not violate their Standards of Apprenticeship.

It is important for Merchant Job Training and Safety to preserve the integrity of our certificate program. Our certificate states that a trainee successfully completing our program has achieved the academic competence to become a Journeyman Lineman. To eliminate uncertainties over where those transitioning to our program should begin, we offer comprehensive tests that enable those who qualify to receive credit for up through the first two years of our curriculum. Utilizing the placement tests minimizes the risk that a trainee may need remedial work, or has to stop and restart the program in an earlier workbook.

## Department of Labor Registration

The Administrator's curriculum may be approved by The US Department of Labor, Office of Apprenticeship. If they wish to have a registered program, it is the prerogative of each utility, or their association, to have their program approved by the U.S. Department of Labor. Additional information is available in our Coordinator's Guide.

## Tuition Payments

Tuition will be billed to the Employer on the first of the month after the Administrator processes the Application Form or Renewal Application, and ships required curriculum materials.

## Tuition Refunds

The Administrator will agree to a reimbursement of tuition in the event of a Trainee's premature drop from training program by the following schedule:

1. Drop Enrollment date to 1st month - 80%
2. Drop 1 month to 2 months - 60%
3. Drop 2 months to 3 months - 40%
4. Drop 3 months to 4 months - 20%

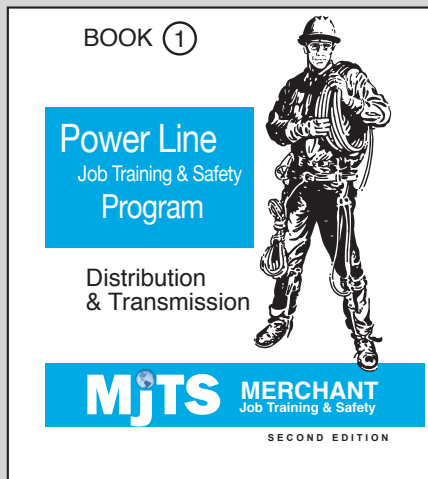
## Shipping

MJTS processes application forms and sends required curriculum materials, workbook and section tests for the program year, shipping by USPS. Shipping is free of charge.





Transmission Line exiting the Deer Creek Generating Station, Elkton South Dakota



# First Year

**Minimum Training Hours: 144**

**Sections: 9**

**Units of Instruction: 37**

**Tests: 9 Section Tests and a Final**

**Tuition: \$550**

## **Block 1 - Introduction to the Electric System**

Introduction to the Electric System  
Substations  
The Transmission System  
The Distribution System  
Poles & Towers  
Grounds & Grounding  
Tree Trimming  
Digging and Setting Poles

## **Block 2 - Basic Electricity**

The Nature of Matter  
Sources of Electricity  
Circuit Fundamentals  
Electromotive Force (voltage)  
Current and Resistance  
Ohm's Law

## **Block 3 - Electrical Math**

Introduction to Fractions  
Fractions Addition & Subtraction  
Fractions Multiplication & Division  
Decimal/Exponent/Prefix  
Advanced Math 1 Algebra  
Percentage  
Vectors

## **Block 4 - Safety**

Introduction to First Aid  
Portable Fire Extinguishers  
OSHA Standards (part 1)  
Wounds

## **Block 6 - Rigging**

Introduction to Fiber Rope  
Hand lines, Blocks, and Slings  
Introduction to Wire Rope  
Splicing and Knot Tying  
Use and Care of Wire Rope

## **Block 7 - Transformers**

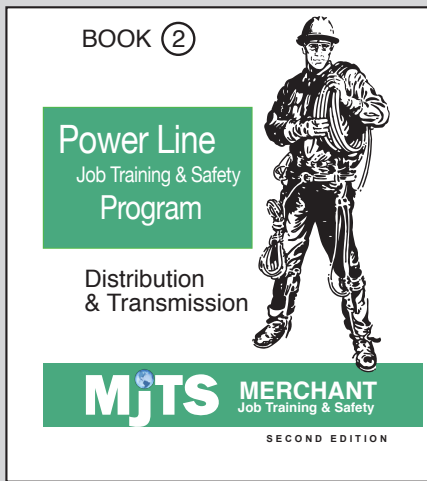
Introduction to Transformers  
Transformer Design  
Insulating Liquid/Transformer Oil  
Polarity of Transformers

## **Block 15 - Orientation**

Climbing Equipment/Climbing

## **Block 19 - Equipment**

Digger Derrick



## Second Year

**Minimum Training Hours: 144**

**Sections: 9**

**Units of Instruction: 33**

**Tests: 9 Section Tests and a Final**

**Tuition: \$550**

### **Block 1 - The Electric System**

Line Conductors  
Joining Line Conductors  
Stringing Line Conductors  
Sagging Line Conductors

### **Block 2 - Basic Electricity**

Power  
Series Circuits  
Parallel Circuits  
Combination Circuits  
Magnetism  
Fundamentals of AC Current

### **Block - Electrical Math**

Ratio  
Ratio & Proportion  
Power & Square Root  
Right Triangles

### **Block 4 - Safety**

Shock  
Specific Injuries  
OSHA Standards (Part 2)  
Respiratory Emergencies

### **Block 5 - Staking/Mapping**

Introduction to Mapping

### **Block 6 - Rigging**

Splicing Double Braid Rope

### **Block 7 - Transformers**

No Load Tap Changer  
Transformer Rating  
Primary System voltages

### **Block 8 - Over-Voltage/Over Current Protective Devices**

Introduction to Arresters  
The Fuse  
The Cutout

### **Block 9 - Live-Line Maintenance**

Introduction to Hot Sticks  
Protective Equipment

### **Block 10 - Voltage Regulation**

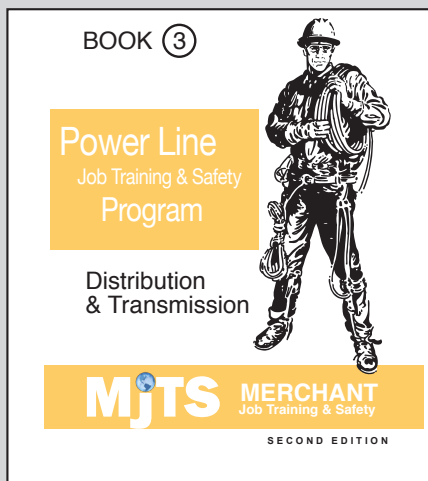
Introduction to Voltage Regulators  
Step Voltage Regulators

### **Block 11 - Power Use**

Batteries  
Consumer's Service

### **Block 14 - Street Lighting**

Street Lighting Systems



## Third Year

**Minimum Training Hours: 144**

**Sections: 9**

**Units of Instruction: 35**

**Tests: 9 Section Tests and a Final**

**Tuition: \$550**

### **Block 2 - Basic Electricity**

Inductance  
Inductive Reactance  
Capacitance  
Capacitive Reactance

### **Block 4 - Safety**

Poisoning  
Poison Plants, Insects & Snake Bites  
OSHA Standards (Part 3)

### **Block 5 - Staking/Mapping**

Specifications & Drawings  
Staking Sheets

### **Block 7 - Transformers**

Introduction to Transformer Connections  
Transformer Connections (Single-Phase)  
Transformer Connections (Three-Phase)  
Transformer Connections (Phase Displacement)  
Transformer Connections (Wye-Delta)  
Transformer Connections (Wye-Wye)  
Transformer Connections (Delta-Wye)  
Transformer Connections (Delta-Delta)

### **Block 8 - Over-Voltage/ Over-Current Protective Devices**

Circuit Reclosers  
Sectionalizers

### **Block 9 - Live-Line Maintenance**

Fault Currents

### **Block 11 - Power Use**

Single-Phase Motors

### **Block 12 - Watt-Hour Meters**

Introduction to Watt-Hour Meters  
Reading Dial Meters  
Meterman's Terms & Definitions

### **Block 13 - Test Meters**

Basic Meters  
Voltage Recorders

### **Block 14 - Street Lighting**

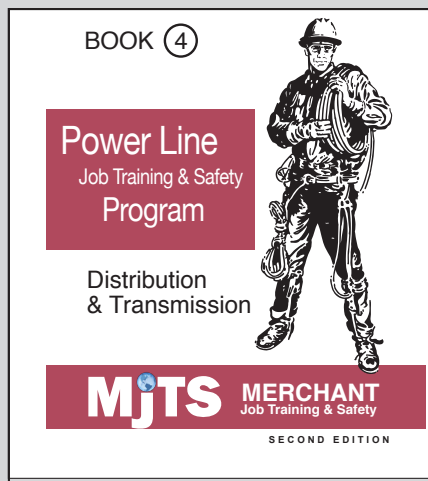
The Luminaire

### **Block 15 - Orientation**

Hydraulics  
Radio Communications

### **Block 17 - Substations**

Introduction to Substations  
Substation Concrete Fundamentals



## Fourth Year

**Minimum Training Hours: 144**

**Sections: 9**

**Units of Instruction: 37**

**Tests: 9 Section Tests and a Final**

**Tuition: \$550**

### Block 2 - Basic Electricity

Series Reactance and Impedance  
Parallel Reactance/Impedance  
Electrical Terms (Review)

### Block 3 - Electrical Math

Advanced Math II (Trigonometry)

### Block 4 - Safety

Electricity & the Human Body  
Rolling Stock  
OSHA Standards (Part 4)

### Block 5 - Staking/Mapping

Mapping Symbols

### Block 7 - Transformers

Transformer Fusing  
Transformer Connections (Fusing Wye)  
Transformer Connections (Fusing Delta)  
Transformer Connections (Open)  
Transformer Connections (Taps)  
Autotransformers  
Extra-ordinary Transformer Connections  
Transformer Calculations & Review  
Transformer Connections Review

### Block 8 - Over-Voltage/Over-Current Protective Devices

System Coordination  
Selection of Sectionalizing Devices

### Block 10 - Voltage Regulation

Boosters

### Block 11 - Power Use

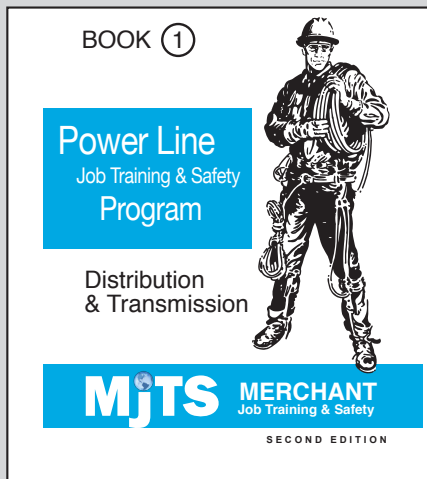
Power Factor  
Power Factor Correction  
Three Phase Motors  
Electrolysis  
Capacitor Bank Application  
Ferro-resonance

### Block 12 - Watt-Hour Meters

Instrument Metering  
Application of Watt-Hour Meters  
Demand Factors  
Reading Dial Meters (Review)

### Block 16 - Underground Distribution

Introduction to UD Systems  
Underground System Design  
UD Cable  
Installing UD Cable  
UD Electrical Apparatus  
UD Fault Locating



# First Year Unit Descriptions

## Block 1 - Introduction to the Electric System

**Introduction to the Electric System** - Provides an overview of the electric system from the generating station to the customer service. Introduces common voltages, electrical devices, switches, and over-current and over-voltage devices.

**Substations** - Introduces transmission, distribution, & switching substations. Relates voltage and capacity. Surveys the function of equipment such as transformers, switches, breakers, potential and current transformers, relays, etc.

**The Transmission System** - Defines the transmission system and briefly survey system history. Introduces AC and DC transmission and pros and cons of each, and factors relating to capacity. Discusses three phase power, rights of way, magnetic and electric field effects, and corona.

**The Distribution System** - Defines distribution, single-phase, two-phase, and three-phase distribution. Introduces three-phase 3-wire & 4-wire, single-phase primary & secondary circuits, and the neutral conductor. Discusses harmonics, interference, neutral to earth voltage, stray voltage, and primary system isolation.

**Poles & Towers** - Introduces wood, aluminum, concrete, fiberglass, and steel structures. Discusses proper loading, unloading, hauling, erecting, and setting of poles. Trainees learn assembly, care, and erection of steel towers, and identify their parts.

**Grounds & Grounding** - Introduces substation and distribution grounding, the effect of soil conditions on ground resistance, allowable ground resistance, and allowable distance between grounds on multi ground systems and equipment & conductors normally connected to it. Introduces counter-poise, ground rods, & minimum ground conductor size.

**Tree Trimming** - Trainees learn fundamental abilities required of tree trimmers, seasonal limits on tree pruning, and natural tree trimming. Poisonous plants and first aid, danger trees, and spraying of rights-of-way are introduced.

**Digging and Setting Poles** - Describes tools and procedures for digging and setting poles, plumbing & tamping of poles, and precautions to take when working around energized conductors. Explains digging and setting poles in sand or marshy areas, push braces, cribbing and installing pole keys, and digging poles by hand and with augers.

## Block 2 - Basic Electricity

**The Nature of Matter** - Introduces the nature of matter, identifies atomic particles & the atomic structure and the relationships and effects that these particles have on one another. Defines the free electron, electron drift, characteristics of good conductors and insulators, and defines matter and its states - solid, liquid, and gas.

**Sources of Electricity** - Identifies the six sources of electricity - friction, pressure, heat, light, chemical, and magnetic. Describes thermocouples and thermopiles. Defines ions, ionization, and positive & negative ions.

**Circuit Fundamentals** - Explains how positive & negative particles attract and repel. Identifies diagrams and schematics, introduces direction of current flow in circuits, and states concepts involved in Ohm's Law.

**Electromotive Force (voltage)** - Introduces definitions of electrical terms such as the joule, the coulomb, potential difference, voltage, and polarity. Explains application of volt meters to electric circuits.

**Current and Resistance** - Explains the effect of applying voltage to a circuit, the direction of current flow, and the effect of resistance on current flow. Introduces resistivity, conductivity, and conductor dimensions and their relationship to conductor resistance.

**Ohm's Law** - States Ohm's Law and algebraically finds its three forms. Introduces concepts of direct and inverse proportion as they relate to Ohm's Law. Demonstrates solving for an unknown parameter in Ohm's Law with the other two given, including solution of practical word problems.

## Block 3 - Electrical Math

**Introduction to Fractions** - Introduces parts of fractions, common denominators, proper and improper fractions, and mixed numbers. Dividing and shading figures to represent fractions and solve simple problems by this method is detailed.

**Fractions Addition & Subtraction** - Trainees learn to add and subtract fractions and mixed numbers, expressing them in lowest terms. They apply these principles to practical word problems relating to everyday life and on the job.

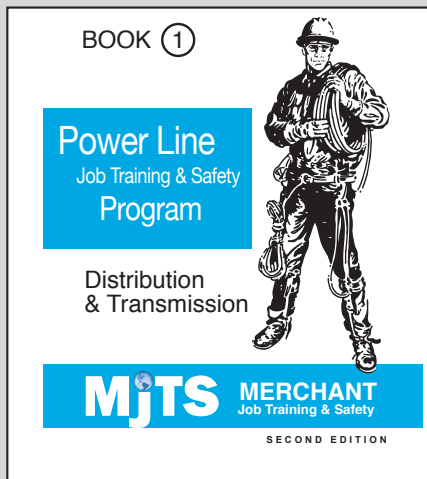
**Fractions Multiplication & Division** - Trainees learn to multiply and divide fractions and express in lowest terms. They apply these principles to practical word problems relating to everyday life.

**Decimal/Exponent/Prefix** - Introduces writing mixed fractions and numbers given in words into decimal notation. Trainees learn to divide numbers with both positive and negative exponents, and to convert decimal numbers between metric prefixes.

**Advanced Math 1 Algebra** - Introduces combining like terms in equations and solving for variables in simple algebraic expressions. Trainees apply these concepts to simple practical word problems.

**Percentage** - Trainees learn to convert between decimal numbers and percentage. They apply the percentage formula to solve for base, rate, and the part, applying to practical word problems.

**Vectors** - Defines the vector and identifies its parts, introduces two graphical methods for adding and subtracting vector quantities. Trainees apply vectors to simple practical problems, measuring magnitude and angle or their results.



# First Year Unit Descriptions (continued)

## Block 4 - Safety

**Introduction to First Aid** - Defines First Aid and awareness necessary to promote safety. Introduces general safety considerations in positioning accident victims and identification of poison related accidents.

**Portable Fire Extinguishers** - Introduces common fire extinguishers used by electric utilities. Associates combustibles with classes of fire. Explains the hazards of fire fighting. Gives safety precautions to be taken before starting work where fire hazards exist. Surveys tools recommended for fire fighting.

**OSHA Standards (part 1)** - Introduces terms and definitions related to safety rules pertaining to work at electric utilities and responsibilities for safety relating to every day activities of line personnel.

**Wounds** - Introduces open and closed wounds, and symptoms and first aid treatments for each, controlling bleeding, protecting open wounds, symptoms of infection, and precautions taken in animal bites.

## Block 6 - Rigging

**Introduction to Fiber Rope** - Explain rope construction and identify ropes as to their application to the utility industry, introduce precautions and safety factor for rope and discuss natural and synthetic fibers.

**Hand lines, Blocks, and Slings** - Introduces use, storage, inspection, and requirements of the hand line. Defines common knots used by ground men, and define the snatch block and attaching snatch blocks and slings to poles. Explanation of rope capacity over time.

**Introduction to Wire Rope** - Explains construction of wire rope, and their grades. Identifies factors in selecting wire rope and safety factors pertaining to personnel, equipment, and material.

**Splicing and Knot Tying** - Defines terms used in rigging of rope. Identifies hitches, knots, and splices commonly used by line personnel, and methods of finishing ends of rope.

**Use and Care of Wire Rope** - Introduces procedures for removing from reels and cutting, attaching U-bolt clips, characteristics of good lubricant, proper lay for application to drums, formulas for safety factor.



## Block 7 - Transformers

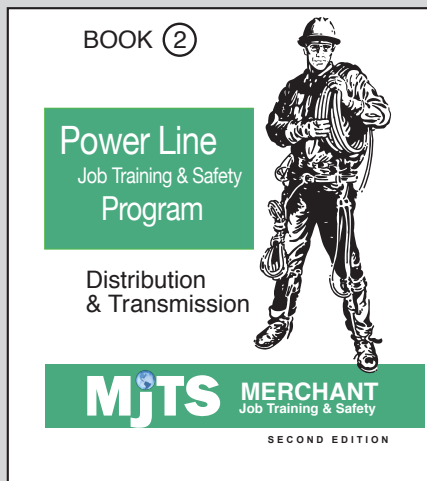
**Introduction to Transformers** - Surveys transformer history, application to AC current, its function in economical power delivery, transformer classifications, and mutual induction versus Auto-transformers.

**Transformer Design** - Explains basic design considerations and construction of transformers, transformer losses, core and winding types, insulation, and insulating liquids.

**Insulating Liquid/Transformer Oil** - Explains the function of oil in electrical apparatus, impurities that contaminate oil, moisture detection, and standards for testing, filtering, and replacing transformer oil.

**Polarity of Transformers** - Introduces testing transformers for polarity, terminal markings for additive versus subtractive transformers, and transformer coil voltage and kVA capacity as it relates to polarity.





# Second Year Unit Descriptions

## Block 1 - The Electric System

**Line Conductors** - Introduces relative advantages and disadvantages of copper and aluminum. Defines AWG wire sizes and circular mil areas, loading districts, and conductor code words. Trainees calculate weight and resistance from tables, introduce dampers, bundle spacers, and fiber-optic cables.

**Joining Line Conductors** - Introduces tension splices and their limitations, describe proper cleaning before joining and the purpose of filler paste and its active compound. Describes splice joints, sleeve joints, compression joints, thermal joints, internally fired joints, automatic tension joints, pre-formed joints, and bolted joints.

**Stringing Line Conductors** - Explains objectives of stringing operations, stress protecting conductors. Describes slack and tension stringing, grounding requirements in stringing operations, and equipment used for grounding. Introduces the puller, the tensioner and proper sizing of bull wheels.

**Sagging Line Conductors** - Explains sagging by sight, transit, dynamometer, and timing. Describes safety precautions taken when sagging around energized conductors, effects of wind and temperature on sagging. Introduces shunt and series dynamometer, and familiarizes trainees with use of formula for sag in inches for given conditions.

## Block 2 - Basic Electricity

**Power** - Defines energy, work, and power and their units of measure. Explores various forms of the power formula, introduces ratio and proportion and their application to electrical problems.

**Series Circuits** - Defines symbols and abbreviations used in series circuits. Explains rules pertaining to current, voltage, resistance, and power in series circuits. Looks at difference between open circuits, and partial and direct shorts.

**Parallel Circuits** - Surveys differences between series and parallel circuits, plus rules for current, voltage, resistance, and power in parallel circuits. Trainees calculate total resistance using the equal branch, unequal branch, and reciprocal methods.

**Combination Circuits** - Trainees trace current flow paths and identify points where current divides and recombines. They simplify and redraw combination circuits. They also demonstrate effects of opens and shorts in various parts of combination circuits.

**Magnetism** - Introduces magnetic poles, lines of force, permanent magnets, magnetic domains, and electromagnetism. Explains the left hand rule, and explores field interaction between current carrying conductors and resulting force exerted on those conductors.

**Fundamentals of AC Current** - Compares AC and DC current properties. Reviews induction as a source of electricity, and explains operation of AC generators. Defines the sine wave, peak voltage, the cycle, frequency, the period, instantaneous values, and average & effective values of voltage and current. Explains phase difference between voltages by utilizing two generators that are 90° out of phase.

## Block - Electrical Math

**Ratio** - Trainees set up ratios related to length, electrical units, money, liquid measure, and time. They solve word problems relating to gears, transformer turns ratio, efficiency, meter multipliers, and right triangles.

**Ratio & Proportion** - Introduces concepts of direct and inverse proportion. Trainees set up proportions and solve problems relating to weight, electrical circuits, and transformers.

**Power & Square Root** - Defines square, cube, and powers. Trainees calculate values of numbers raised to various powers.

**Right Triangles** - Defines the right triangle and equilateral triangle. Identifies the hypotenuse, altitude, and base. Trainees apply Pythagorean theorem to solve right triangles for their missing side.

## Block 4 - Safety

**Shock** - Defines shock, common causes of shock, signs and symptoms of shock, First Aid steps taken in treating and preventing shock, and fluid administration in the case of delayed medical attention.

**Specific Injuries** - Introduces signs and symptoms of eye injury, cautions, and First Aid treatment for foreign bodies in eyes. Summarizes steps taken for chemical exposure to eyes and First Aid to be given. Finally, signs and symptoms of nose injuries are introduced. First Aid treatment for broken nose, nosebleeds, and follow-up to nose bleeds is detailed.

**OSHA Standards (Part 2)** - APPA Safety Manual, Section 1 - General Rules. Topics include employee responsibility for safety, reporting employee injuries, reporting utility vehicle accidents, reporting hazardous conditions, taking chances, practical jokes, guards, hazardous energy control/lockout-tagout, warnings, intoxicating beverages and drugs, housekeeping, smoking, clothing, eye and face protection, supplemental breathing equipment, fall protection, life jackets, head protection, wearing apparel, hand tools, portable electric tools, pneumatic tools, hydraulic tools, power lawn mowers, edgers, etc., power-actuated tools, safe supports and scaffolds, ladders, straight ladders, step ladders, material handling and storage, explosives, compressed gasses, welding and cutting, and acids and caustics.

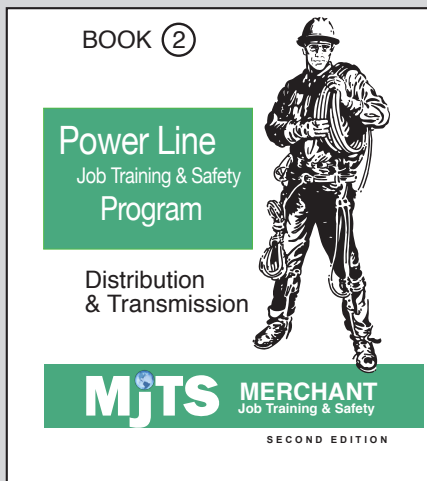
**Respiratory Emergencies** - Describes the breathing process, causes and signs & symptoms of respiratory failure, and First Aid treatment for various incidences of respiratory failure.

## Block 5 - Staking/Mapping

**Introduction to Mapping** - Defines the blueprint. Summarizes use of drawings in the electrical industry; Architectural Drawing, Structural Drawing, Mechanical Drawing, Electrical Drawing, Construction Drawing, Vicinity Drawing, Plan and Profile, Clearing Diagram, Condemnation Drawing, and Specification Drawing.

## Block 6 - Rigging

**Splicing Double Braid Rope** - Reviews three types of fiber rope and relative advantages & disadvantages. Describes making of the eye splice and backlash with double braided rope.



## Second Year Unit Descriptions (continued)

### Block 7 - Transformers

**No Load Tap Changer** - Introduces mutual induction and turns ratio. Trainees set up relationships and perform calculations with transformer turns, voltage, and current. They work with ratio and proportion pertaining to transformer calculations and calculate tap settings based on transformer coil voltage and system voltage.

**Transformer Rating** - Transformer nameplates, kVA ratings, and high & low side ratings are reviewed, along with standard nameplate symbols used to state voltage ratings. Formats are covered for stating voltage ratings of grounded-wye, delta-only, and delta-wye application. Additionally, low side ratings for transformers with series parallel capability, 3-phase 4-wire capability, and dual voltage center tap connections are reviewed. Transformer ratings are given for transformers with three bushings and internal connections, and four bushing transformers using external connections.

**Primary System voltages** - Trainees draw vector diagrams of delta and wye systems, using a protractor and ruler and they identify phase and line voltage values. They determine the three phase constant to calculate line voltages from phase values, and survey standard primary system voltages.

### Block 8 - Over-Voltage/Over-Current Protective Devices

**Introduction to Arresters** - Presents three methods of preventing voltage surges. Details the function and classes of arresters and voltage level of each. Defines Basic Impulse Level and associates it with proper arrester selection.

**The Fuse** - Introduces fuse classifications, the expulsion principle, and how an arc extinguishes. Describes fuse links, time-current curves, and relates them to system coordination.

**The Cutout** - Introduces NEMA as the controlling agency for standardization of electrical equipment design, and surveys NEMA ratings for cutouts. Explains conversion of cutouts to disconnect switches and gives their ratings. Classifies cutouts and their operating principles, and explains safe cutout operation.

### Block 9 - Live-Line Maintenance

**Introduction to Hot Sticks** - Outlines traits of good hot-line lineman prospects, qualities of good hot-line tools, and critical factors in their care, practical application of various tools, tying and untying of tie wires, and hot-line safety procedures.

**Protective Equipment** - Explains rubber glove specifications, use and care of rubber goods, rubber sleeves, rubber insulating line hose, hoods, and blankets. Discusses polyethylene covers, conductor covers, insulator covers, cross arm covers, and pole covers.

## Block 10 - Voltage Regulation

**Introduction to Voltage Regulators** - Introduces TCUL transformers, step regulators, induction voltage regulators, auto-boosters, booster transformers, and capacitor banks.

**Step Voltage Regulators** - Transformer classifications - mutual induction & autotransformers are discussed. Covers double throw switches as they apply to voltage regulators, regulator control mechanisms, and determination autotransformer output based on turns ratio and step setting. Considerations for bypassing regulators are reviewed.

## Block 11 - Power Use

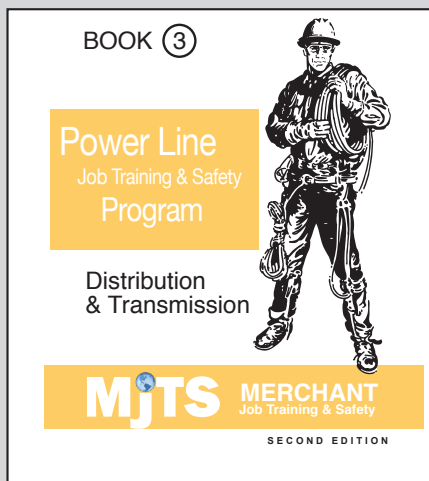
**Batteries** - Trainees learn about primary and secondary batteries, wet and dry cells, rejuvenation of dry cells, indications of "used up battery," lead-acid cell charging, testing and specific gravity, and electrode potential and the ion.

**Consumer's Service** - Trainees identify consumer system ratings from diagrams and voltages available phase-phase & phase-neutral. Outlines distribution services, ground clearance, and maximum service drop span by NESC. Details service entrances, grounding, temporary service, and farmyard poles.

## Block 14 - Street Lighting

**Street Lighting Systems** - Luminaire classifications, discharge lighting, and need for ballasts. Types of lighting circuits, voltages encountered, precautions, and mechanics of installing streetlight and streetlight control.





## Third Year Unit Descriptions

### Block 2 - Basic Electricity

**Inductance** - Defines inductors, inductance, induction, and counter electromotive force. Introduces air core and iron core inductors. Reviews four factors affecting inductance, introduces the henry, coefficient of coupling, and transformer ratios. Trainees solve for total inductance in series and parallel circuits.

**Inductive Reactance** - Defines inductance, reactance, inductive reactance, impedance, reactive power, true power, frequency, and angular velocity. Trainees calculate inductive reactance from inductance and frequency, define the inductive time constant, introduce phase relationship between voltage and current, apply Ohm's Law in AC inductive circuits.

**Capacitance** - Defines capacitance, dielectric, and describes the electrostatic field within a capacitor. Explains physical factors affecting value of capacitance, and computing total capacitance in series and parallel. States relationships between farads, volts, electric charge, and voltage.

**Capacitive Reactance** - Differentiates between inductance and capacitance in AC circuits. Defines capacitive reactance and the formula for computing capacitive reactance from frequency and capacitance. Introduces phase relationship between voltage and current in capacitive circuits. Trainees compute impedance in a series capacitive circuit and a series RC circuit. They also calculate power factor in RC circuits.

### Block 4 - Safety

**Poisoning** - Defines poisoning and four avenues for poisons to enter the body, inhalation, ingestion, absorption, and injection. Identifies frequent causes of poisoning around the household. Trainees are introduced to signs and symptoms of poisoning, information that must be relayed by telephone to medical help, and to First Aid steps that must be taken to help a poisoning victim.

**Poison Plants, Insects & Snake Bites** - Trainees are introduced to common poisonous plants, insects, and snakes. Signs and symptoms of poisoning by these means are reviewed along with appropriate First Aid treatments that can be administered.

**OSHA Standards (Part 3)** - Trainees review safety standards specific to health and environmental control, vehicle operations, work area protection, and fire protections. Trainees sharpen their recollection of the standards by working crossword puzzles.

## Block 5 - Staking/Mapping

**Specifications & Drawings** - Identifies prefixes used in construction drawings and reviews written specifications. Identifies information given on pole brands and their placement. Reviews rules involving grounding of electrical equipment and minimum ground wire size, safety codes and regulations, facing poles during construction, raking poles, grading line, installing anchors, and splicing conductors.

**Staking Sheets** - Reviews importance of staking sheets and those who rely on them. Introduces the process of drawing up a staking sheet; trainees learn to sketch for the staking sheet, and avoid cluttering it unnecessarily.

## Block 7 - Transformers

**Introduction to Transformer Connections** - Trainees draw a vector diagram of a 3-phase 4-wire system to scale and label phases and neutral conductor, calculate phase voltage and line voltage. They give the ratio of line-to-phase voltage. They determine transformer coil voltage from system voltage and the transformer connection. Transformer ratings are reviewed.

**Transformer Connections (Single-Phase)** - Reviews the distribution system, voltage vectors, consumer's service, transformer rating, and primary system voltages. Introduces a 12-step method used to diagram 1-phase transformer connections. Trainees draw vector diagrams of primary system voltages, determine line and phase voltage. They make common transformer connections using the 12-step procedure.

**Transformer Connections (Three-Phase)** - Reviews common voltage ratings for residential services. Describes the wye and delta connection. Trainees determine high & low side connections based on transformer rating & system voltage.

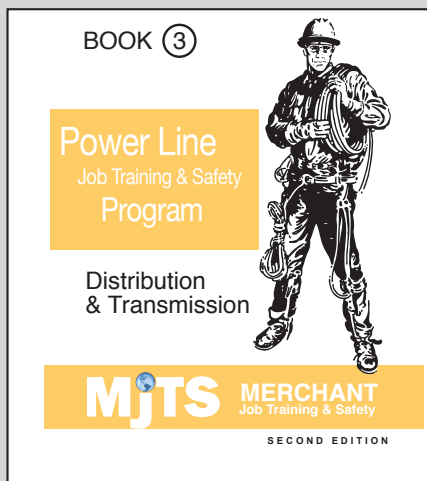
**Transformer Connections (Phase Displacement)** - Defines transformer phase displacement. Gives the possible phase displacements given the four possible three phase connections for both standard and alternate displacements. Trainees construct a "vector guide" to assist trainees in manipulation of vectors and phase displacement.

**Transformer Connections (Wye-Delta)** - Defines the floating high side connection and advantages & disadvantages of floated and grounded wye high side. Gives examples of secondary service ratings that require delta low side, make wye-delta connections by the vector method.

**Transformer Connections (Wye-Wye)** - Gives advantages and disadvantages of wye-wye connection and requirements of grounding wye-wye connection. Reviews customer service that requires a secondary wye connection. Trainees make wye-wye transformer connections by the vector method.

**Transformer Connections (Delta-Wye)** - States biggest advantage of low side wye connection. Introduces the connection required to test a transformer for percent impedance. Trainees calculate impedance from high side voltage required to produce rated low side current. They demonstrate the ability to make delta-wye connections by the vector method.

**Transformer Connections (Delta-Delta)** - Introduces importance of impedance to delta high side connections, the effect of differences in the relative impedance of delta connected transformers, and the effect of high circulating currents within the delta. Trainees demonstrate the ability to make delta-delta connections by the vector method.



## Third Year Unit Descriptions (continued)

### Block 8 - Over-Voltage/Over-Current Protective Devices

**Circuit Reclosers** - Describes the oil switch and its function in breaking an arc. Differentiates between permanent and temporary faults, and the application of reclosers in clearing temporary faults. States ratings for reclosers and relates them to standard, intermediate, and heavy duty reclosers. Trainees work with time-current curves and relate them to coordination of sectionalizing devices.

**Sectionalizers** - Describes the terms protected and protecting device. Introduces the mechanism by which sectionalizers detect fault current, and how it depends on the recloser for its ability to function. Reviews advantages & disadvantages of sectionalizers compared to other sectionalizing devices.

### Block 9 - Live-Line Maintenance

**Fault Currents** - Defines fault current and primary factors governing value of fault current on a circuit. Compares fault current on open wire and underground cable, and the effect inductance has on changes in current flow. States precautions to take in selecting arrestors. Identifies features of cutouts that allow its use on high fault current circuits. Relates problems with CSP transformers on high fault current circuits.

### Block 11 - Power Use

**Single-Phase Motors** - Explains right and left hand rule and torque production. Gives a brief history of motors, and how 3-phase motors have simpler construction but more expensive regarding availability of 3-phase at the service entrance.

### Block 12 - Watt-Hour Meters

**Introduction to Watt-Hour Meters** - Details how the potential coil and voltage coil are connected into the circuit, how torque is produced on a disk to produce rotation, and what determines how fast it turns. Names principle parts of a meter. Defines power, watt, energy, watt-hour, register, watt-hour constant, stator and rotor.

**Reading Dial Meters** - Introduces reading four and five dial meters, calculate actual monthly consumption from present and previous meter readings, using register constant and the register reading.



**Meterman's Terms & Definitions** - Introduces terms and definitions relating to watt-hour meters.

## Block 13 - Test Meters

**Basic Meters** - Identifies basic meter movements, explains how variation in current effects magnitude of meter readings. Explains operation of electromagnetic and thermal meter movements. Discusses linear and non-linear meter scales. Introduces basics of electronic meters.

**Voltage Recorders** - Surveys strip type and paperless voltage recorders.

## Block 14 - Street Lighting

**The Luminaire** - Defines radiant energy, electromagnetic waves, radio waves, and light waves. Explains the effect on the eye of different wave lengths in the visible electromagnetic spectrum, review the three primary colors. Defines absorption, reflection, and diffusion, units of measure of light, and explains efficiency of light. Gives four sources of visible electric light. Describes incandescent lamps, fluorescent lamps, and electric discharge lamps.

## Block 15 - Orientation

**Hydraulics** - States Pascal's law and its relationship to hydraulic systems. Explains basics of the hydraulic system and advantages over mechanical means of transmission. Defines holding valve, pressure relief, reserve tank, hydraulic pump, and collector block. Names five principle parts of a hydraulic system. Describes proper maintenance procedures and considerations for cold weather operation.

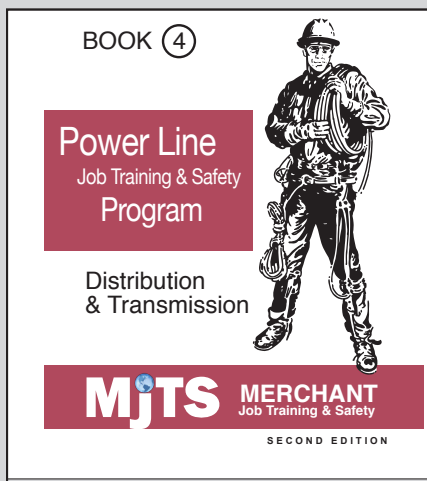
**Radio Communications** - Introduces the FCC as the controlling agency over radio communications, and licensing requirements for station and mobile units. Introduces signals used by utilities and work activity that has priority on two-way radio.

## Block 17 - Substations

**Introduction to Substations** - Considerations for planning, location, and engineering design of substations. Reviews functions of distribution, transmission, and switching substations.

**Substation Concrete Fundamentals** - Identifies references used in alignment of concrete pads and tools necessary to assure proper elevation of concrete pads. Explains why metal is used for a base plate in constructing footings for steel towers. Describes how to prevent bolts from being knocked out of place during pouring and use of grease to protect threads on anchor bolts. Explains how to give concrete pads extra strength to assure greater support for heavy loads.





# Fourth Year Unit Descriptions

## Block 2 - Basic Electricity

**Series Reactance and Impedance** - Defines impedance and the series RLC circuit. Introduces representing impedances in an RLC circuit as vectors, finding net reactance, drawing the impedance triangle, and solving for the hypotenuse to find impedance. Trainees calculate component voltage, represent voltages as vectors, find net reactive voltage, represent voltages as a right triangle, and find the total voltage with Pythagorean's Theorem.

**Parallel Reactance/Impedance** - Defines the parallel RLC circuit. Introduces finding current through each parallel component, representing the branch currents as vectors, finding net reactive current, drawing the current triangle, and solving for total current by solving for the hypotenuse. Explains finding total impedance by the unequal branch method in RC or RL circuits and by Ohm's Law using total applied voltage and total current.

**Electrical Terms (Review)** - Trainees review electrical terms from the four years of the program and test their memory by working out a crossword puzzle.

## Block 3 - Electrical Math

**Advanced Math II (Trigonometry)** - Trainees review the right triangle and Pythagorean's Theorem. The sine, cosine, and tangent functions are introduced as ratios of two sides of the right triangle. Trig tables are introduced, along with the concept of the ratio of sides being dependent on the angle. Trainees solve practical word problems using right triangle trigonometry.

## Block 4 - Safety

**Electricity & the Human Body** - Introduces factors that affect current flow through the body, effects on the body versus current magnitude, critical difference between pathways through the body, and hazards of working on electrical equipment in wet conditions.

**Rolling Stock** - Details critical areas for inspection of vehicles, precautions to take when refueling, procedures and precautions when parking near roadways, points to remember when backing-up, procedures when hauling poles, procedures for testing rigging on cranes, precautions when using cranes in energized locations, and procedures for use of aerial baskets.

**OSHA Standards (Part 4)** - Trainees review safety standards specific to overhead distribution and transmission, tree trimming, underground lines and equipment, underground residential distribution, generating stations, communication facilities, and office safety.

## Block 5 - Staking/Mapping

**Mapping Symbols** - Trainees are introduced to symbols commonly used on “key” and “detail” maps. The symbols are classified by electrical, boundaries, lettering, hydrographic features, topographic features, and cultural features.

## Block 7 - Transformers

**Transformer Fusing** - Trainees are introduced to fusing considerations for high side connections; wye, delta, open-wye, and open-delta. Trainees determine coil voltage based on system voltage and the high side connection, calculate coil current from coil voltage, and transformer kVA rating, they determine line current based on the transformer connection, and then calculate the current value to use in sizing transformer fuses.

**Transformer Connections (Fusing Wye)** - Trainees work out high side wye connections by the vector method and then calculate coil currents, line currents, and line current value to be used for sizing transformer fuse size.

**Transformer Connections (Fusing Delta)** - Trainees work out high side delta connections by the vector method, then calculate coil currents, line currents, and line current values to be used for sizing transformer fuses.

**Transformer Connections (Open)** - Trainees are introduced to open wye-open delta connections, vector diagrams of the open wye-open delta connection, and limitations placed on use of open wye connections. Given system voltage, transformer rating, secondary system, and phase displacement, trainees use the vector method to work out transformer connections. They determine primary coil voltage, primary coil current, primary line current, and determine the current value needed to size transformer fuses.

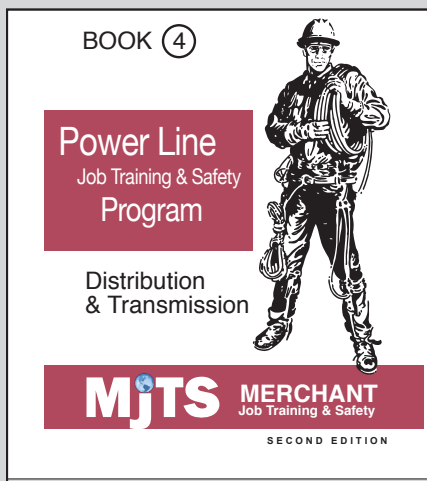
**Transformer Connections (Taps)** - Given system voltage, transformer rating, secondary system, and phase displacement, trainees use the vector method to work out various transformer connections. They use system voltage and transformer rating to calculate necessary tap settings. They calculate primary coil voltage, primary coil current, line current, and the current value need to size transformer fuses.

**Autotransformers** - Trainees review the differences between mutual induction and autotransformers, and are introduced to advantages and limitations of autotransformers. They calculate output voltage of autotransformers given input voltage and turns ratios, as well as primary and secondary currents. They explain kVA rating of mutual inductance transformers and autotransformers.

**Extra-ordinary Transformer Connections** - Trainees are introduced to two phase systems, 2-phase 4-wire systems, 2-phase 3-wire systems, 2-phase 5-wire systems. Conversion from 3-phase to 2-phase using conventional and the Scott Connection is presented. Also presented is the connection for 120/208 3-phase 3-wire & 120/240 1-phase 3-wire. A connection to provide 120/208 3-phase 4-wire when only two primary phases and a neutral are available is introduced. Finally, balancing large single-phase loads onto a three-phase feeder using 120/208 Network 3-wire service is presented.

**Transformer Calculations & Review** - Trainees learn to calculate transformer bank rating for given closed delta and open delta banks. They draw vector diagrams for system voltages, and label the vectors the diagrams for the system voltages. They are introduced to calculating power loads from given values of system voltage and load current. They determine residential transformer capacity and calculate transformer voltage drop and secondary conductor voltage drop. Finally, they learn to size transformers for an unbalanced 3-phase bank such as the 120/240 V 3-phase 4-wire with large single phase load.

**Transformer Connections Review** - In this unit, trainees review transformer connections and calculations and demonstrate their abilities with the more common transformer connections.



## Fourth Year Unit Descriptions (continued)

### Block 8 - Over-Voltage/Over-Current Protective Devices

**System Coordination** - Introduces trainees to fundamentals of making a sectionalizing study, location of sectionalizing devices, and calculation of maximum and minimum fault currents. They are introduced to 3-phase ground faults, double line-to-ground faults, single line-to-ground, and line-to-line faults.

**Selection of Sectionalizing Devices** - Trainees review circuit reclosers, sectionalizers, fused cutouts, and circuit breakers. They are introduced to limitations of sectionalizer devices and their interrupting capability. They learn methods to coordinate reclosers to fuses and the sequence of operations required by the recloser.

### Block 10 - Voltage Regulation

**Boosters** - Trainees are introduced to using a standard transformer as a temporary booster to accomplish an increase or decrease of line voltage by 5 or 10%. Dangers and precautions related to proper handling of a booster transformer and reasons for not fusing the high side of a booster are discussed.

### Block 11 - Power Use

**Power Factor** - Power factor, apparent power, true power, and reactive power are defined. Trainees are introduced to representing these powers as vector quantities, determining net reactive power, and constructing the power triangle. They calculate power factor in RC, RL, and RLC parallel circuits and are introduced to the concept of power factor correction.

**Power Factor Correction** - Trainees learn to calculate power factor from given loads. They draw the power triangle and determine phase angle and power factor using a ruler and protractor. They calculate the capacitor bank rating necessary to correct a given load to 100% power factor.

**Three Phase Motors** - Trainees are introduced to the major types of three phase motors in use today, and their basic construction. They learn basic operation of synchronous, squirrel-cage, and wound-rotor three phase motors, and the procedure for reversing the rotation of a three phase motor. They are also introduced to wye and delta motor winding connections.

**Electrolysis** - Trainees are introduced to a voltaic cell and how this cell relates to electrolysis of metals. The term electrode potential is defined, as well as calculating the voltage generated from the combination of various metals. Trainees learn variables that determine the rate of oxidation-reduction and why using sacrificial metals for grounding is dangerous. Sacrificial anodes are introduced, along with proof-testing sacrificial anodes. Trainees learn oxidation-reduction and various corrosion problems related to overhead and underground systems.

**Capacitor Bank Application** - Units of measure for real, reactive, and apparent power are reviewed, as well as formulas for calculating power factor. They are given a method for determining the best location and size of a permanent capacitor bank. They are introduced to proper application of capacitors relating to proper connections and grounding of capacitor banks. They calculate power factor of circuits and correct them to a given power factor. They calculate capacitor fuse sizes and review safety requirements for disconnecting and removing capacitors from service.

**Ferro-resonance** - Trainees are introduced to the mechanisms behind ferro-resonance. They learn variables affecting ferro-resonant situations, along with two transformer connections that are resistant to ferro-resonance. They are also given procedures protecting a system against ferro-resonance.

## Block 12 - Watt-Hour Meters

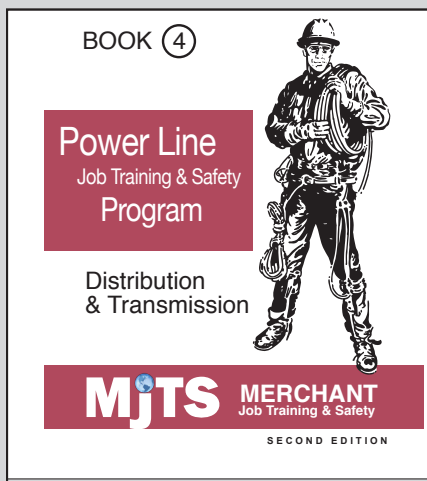
**Instrument Metering** - Trainees are introduced to potential and current instrument transformers, their purpose, their terminal markings, and their polarity. They calculate potential, current, and watt-meter multipliers. They calculate the value of voltage at the meter of a substation meter. They learn ratings for capacity, voltage, and error for potential transformers, as well as secondary ratings of both the current and potential transformers and their application to metering situations.

**Application of Watt-Hour Meters** - Trainees review definitions of metering terms. They review the units of measure for energy and the time period for recording maximum demand. They learn capacity limitations placed on self contained meters, and the full load current and voltage of transformer rated meters. They are introduced to advantages of the S base meter compared to the A base meter. They learn to apply meters to 1-phase 2-wire service, 1-phase 3-wire service, 3-wire network service, 3-wire 3-phase grounded phase delta service, 3-wire 3-phase ungrounded delta service, 4-wire 3-phase delta service, and 4-wire 3-phase wye service.

**Demand Factors** - Terms relating to demand metering are defined. Trainees are introduced to the types of demand registers and which are most accurate. They learn the difference between primary, secondary, and universal metering. They calculate load factor given maximum demand and average demand, and learn why load factor is critical to economic distribution of power.

**Reading Dial Meters (Review)** - Trainees practice reading dial meters on progressively difficult examples.





## Fourth Year Unit Descriptions (continued)

### Block 16 - Underground Distribution

**Introduction to UD Systems** - Trainees are introduced to advantages and disadvantages of underground systems, and why overhead systems are relatively less expensive. They learn types of older and newer insulation for underground cable, advantages of direct buried over the duct system, and the advantages of joint use. They also learn to recognize unsafe conditions when working on underground.

**Underground System Design** - Trainees are introduced to radial, loop, loop on loop, duplicate, and the secondary network systems.

**UD Cable** - Trainees are introduced to types of cable insulation and why voids are so critical to reliability or underground cable, and the insulation failure process. They learn voltage levels requiring shielded cables, and they identify shielded cable parts. The terms skin effect and stop joints are defined, as well as hollow cables and pipe-type cables. Oil and gas are introduced as effective insulation on high voltage transmission cables.

**Installing UD Cable** - Terms related to installing underground cable are defined. Procedures for installing direct buried cable by use of a trencher, backhoe, cable plow, and by special tunneling equipment, as well as precautions necessary with use of this equipment are described. Trainees are introduced to the riser and associated equipment.

**UD Electrical Apparatus** - Trainees are introduced to pad-mounted, submersible, direct-buried, and pole mounted electrical equipment.

**UD Fault Locating** - Trainees learn the most common cause of faults on underground systems and the definition of a cable fault. They are introduced to the steps taken to confirm, characterize, localize, and locate a cable fault. Series and shunt faults are defined. Terminal and tracer fault locating equipment, the megohmmeter, as well as fault indicators and their classifications are described. Personal protective equipment that should be worn by line personnel when working on cables is indicated.





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