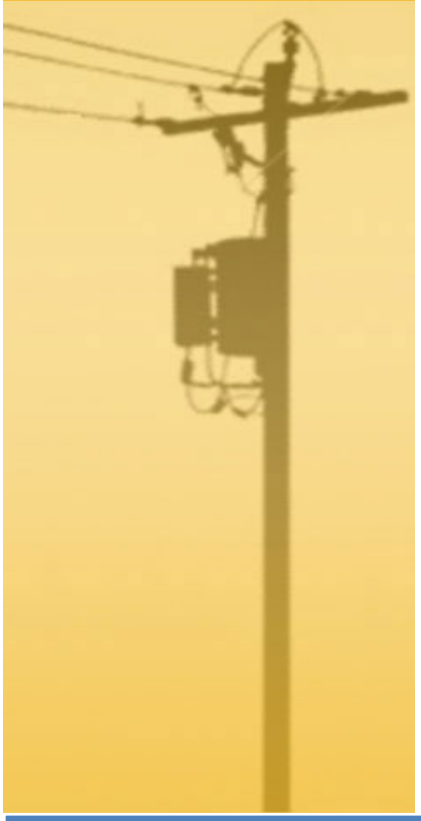

Linemen Instructor's Packet

April 15, 2019
Spring Semester
Salt Lake Community College
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Salt Lake Community College

STEP AHEAD.

U.S. DEPARTMENT OF ENERGY

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Contents

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Introduction

If you are new to distance learning in Canvas, the Introductory module should help you get started.

- Introduction to Canvas
- Download and View Syllabus
- Practice Quiz
- Canvas Prerequisites

Home Page

- Announcements
- Syllabus
- Canvas Topics
- Modules
- Quizzes
- APPA Safety Manual
- Glossary

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Course Modules

This instructor packet contains online course instructional summaries, as well as, course assignment and assessment materials as they appear on Canvas.

Course	Modules
Linemen 1110 - 1A	• Course Introduction • Essentials for Linemen - Part 1 • Essentials for Linemen - Part 2 • Climbing Wood Structures • Rigging in Powerline Work - Part 1 • Rigging in Powerline Work - Part2 • Basic Electrical Principals - Part 1 • Basic Electrical Principles - Part2 • Linemen 1110 Midterm • Substations and Switchyards • Substations and Switchyards • Alternating Current • Linemen 1110 Final
Linemen 1120 - 1B	• Course Introduction • Basic Electrical Theories and Principles • Induction Principles and Alternating Current • Transformers • Transformer Construction • Transformer Information. Characteristics • Transformer Operation • Linemen 1120 Midterm • Single-phase Transformer • Conduct Transformer • Energize Transformers Safely • Linemen 1120 Final
Linemen 1210 - 2A	• Course Introduction • Basic Electricity Review • Three-phase Circuit • Awareness in an Electrical Environment - Part 1 • Awareness in an Electrical Environment - Part 2 • Awareness in an Electrical Environment - Part 3 • Constructing Overhead Powerlines • APPA Safety Manual • Linemen 1210 Midterm • Constructing Overhead Powerlines Part 1 • Constructing Overhead Powerlines Part 2

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	• Constructing Underground Powerlines • Linemen 1210 Final
Linemen 1220 - 2B	• Course Introduction • Characteristics of Delta and Wye Systems • Three-phase Transformer Connections • Three-phase Transformer Connections • The Purpose of Transformers • Three-phase Transformer Connections • Three-phase Transformer Connections • Three-phase Transformer Connections • Linemen 1220 Midterm • Apply Vector Principles • Purpose of a Transformer 2 • 3-Phase Transformer Connections 4 • Aerial Devices and Digger Derricks • Rigging in Powerline Work • Linemen 1220 Final
Linemen 2310 - 3A	• Course Introduction • Working with Conductors and Cable • Working with Conductors and Cable • Three-phase Transformation Connections • Build Three-phase Banks to Standard • Apply Transformer Connections - Part 1 • Apply Transformer Connections - Part 2 • Linemen 2310 Midterm • Calculating Load Checks on Delta and Wye Systems • Three-phase Circuits • Installing Personal Protective Grounds • Three-phase Transformer Connections • Linemen 2310 Final
Linemen 2320 - 3B	• Course Introduction • The Purpose of a Transformer - Part 1 • The Purpose of a Transformer - Part 2 • Supplying Quality Power - Part 1 • Supplying Quality Power - Part 2 • Phasing and Paralleling Circuits • APPA Safety Manual - Phasing • Linemen 2320 Midterm • Operating Switchgear • APPA Safety Manual - Switching • Circuit Protection

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	• APPA Safety Manual - Safety with Breakers • Linemen 2320 Final
Linemen 2410 - 4A	• Course Introduction • Live-line Maintenance • Live-line Maintenance • Live-line Maintenance from Aerial Platforms • Working it Hot - Part 1 • Working it Hot - Part 2 • APPA Safety Manual - Minimum Approach Distance • Linemen 2410 Midterm • APPA Safety Manual Section 507 • Stringing Line Conductors • Sagging Line Conductors • APPA Safety Manual • Transformer Turns Ratio Testing • Linemen 2410 Final
Linemen 2420 - 4B	• Course Introduction • Supplying Quality Power - Part 1 • Supplying Quality Power - Part 2 • Supplying Quality power - Part 3 • Outdoor Lighting Systems • Revenue Metering - Part 1 • Revenue Metering - Part 2 • Sizing CT's for Service • Linemen 2420 Midterm • Rigging in Powerline Work • Transformers • APPA Safety Manual • Linemen 2420 Final

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LINEMEN - 1110 1A

	Instructional Summary
Course Description	Students will learn about; Linemen Safety, Isolate and Ground Circuits and Equipment, Climbing & Rigging, Basic Electrical Principles, Substation Operation & Maintenance and AC and DC Transmission.
Student Learning Outcome	Students will understand; Personal Protective Equipment & APPA Protocols, Perform Formal Lockout Procedures, Demonstrate Climbing & Rigging Equipment Proper Use, Calculate Electrical Potential, Current, Resistance and Power, Explain Generation, Transmission & Distributions of Substations, Define Advantages and Disadvantages of AC/DC.
Instructional Activity	In-Class Lectures Interactive/Demo Labs Online Assignments & Assessments
Material/Equipment	Keys for Lab (Miller Campus) Course Access (Canvas)
Duration	Course Jan 13 - May 4, 2012 (13 Weeks) Total Hours of Online Student Work (Estimate): _____ Total Hours of Online Instructor Work (Estimate): _____
Notes	Point of Contact: Online- Karma Wayman x5391 Program- Ashley Sokia x5354

(See the course syllabus for additional details.)

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Class Introduction Module

Assignment: Watch video & change your email

PowerPoint: None

Quiz: Practice

1. Which course are you taking?

   Lineman Apprentice 1A, Correct

2. You have read through the course syllabus.

   True

3. Do you have any questions for your new instructor before class begins?

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Essentials for Linemen - Part 1 Module

Assignment: Guidebook Chapter 1 - Essentials for Linemen

PowerPoint: Induction Fatality

Quiz: Essentials for Linemen

1. Based on the risk formula, if the probability of tipping over while working from a bucket truck is low, but the consequence could be very high, the work is considered low risk.

False

2. The purpose of [a] a rubber glove when doing a pre-use inspection allows a closer look to examine the glove for [b].

a. inflating
b. leaks

3. Before entering a confined space, it is important to test for [a] deficiency and the presence of gases and vapors before removing the cover so that a spark created by the opening of a cover will not cause an [b].

a. oxygen
b. explosion

4. One of the hazards when working excavations or trenches is underground utility lines.

True

5. ____ are generally made with nylon impregnated with neoprene to provide good wear resistance.

Pole straps

6. _____should be used when walking with climbers, especially through ditches, and when storing them in a truck.

Climber guards

7. An employee should become very familiar with _____ regulations so that there is little doubt as to his responsibilities and rights.

OSHA

8. A safety _____ is a great vehicle for promoting workplace safety because it gets employees, supervisors, and management together to solve safety problems.

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Committee

9. A _____ model can illustrate the types of safety functions or elements that must be managed.

Strategic work

10. _____ will show up as white skin areas, typically on the face.

Superficial frostbite

11. _____ is the application of emergency measures such as first aid, cardiopulmonary resuscitation (CPR) and automated external defibrillator (AED) to preserve life and stabilize the effects of an injury or harm until professional help arrives.

BLS

12. The _____ rescue procedure is a generic, one person climbing rescue.

Pole-top

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Essentials for Linemen - Part 2 Module

Assignment: Guidebook Chapter 1 - Essentials for Linemen - Review Questions, APPA Glossary

PowerPoint: None

Quiz: APPA Safety Manual - Vocabulary Quiz

1. Match the word with the correct definition.

- A system with duel circuits to measure elevated electrical potential on the direction boring machine and current flow along the drill string = Strike sensing system
- A hazardous non-conductive and non-combustible liquid used in some transformers and capacitors = Polychlorinated biphenyls (PCB's)
- The word that appears in a rule that must be obeyed as written when it is reasonable to do so = Should
- Intentionally connected to earth through a ground connection with sufficiently low impedance to prevent buildup of voltages = Effectively grounded
- Tests in which fault currents, load current and line dropping currents are used to test power equipment at the equipment's rated voltage or lower = High power test

2. Match the word with the correct definition

- Any man-made cut, trench or depression formed by earth removal = Excavations
- The act of falling before the personal fall protection system begins to arrest the fall = Free Fall
- The ground rules for practical safeguarding of persons during installation, operation or maintenance of electrical equipment = National electrical safety code
- The effective potential difference between any two conductors or between a conductor and a ground = Voltage
- A device for opening and closing or changing the the connection of a circuit = Switch

3. Match the word with the correct definition.

- A vault that has provision for air changes using exhaust flue stacks and provides for airflow to prevent a hazardous atmosphere = Vented vault
- A major uncontrolled emission, fire or explosion involving hazardous chemicals that presents a serious danger = Catastrophic release
- Excavation to prevent cave-ins by forming horizontal levels or steps = Benching
- A card or tag device that warns against the operation of a particular switch or device = Hold Card
- A connection point along a transformer winding that allows the number of turns to be selected = Load tap Changer

4. Match the word with the correct definition.

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- An electrical, mechanical, hydraulic, chemical, nuclear or thermal source that could cause injury to personnel = Energy source
- Any electrical circuit that normally operates at less than 600 volts = Secondary voltage
- The word that appears in a rule that must be obeyed as written = Shall
- A steerable, horizontal boring machine that allows trenchless installation of underground utilities = Directional boring machine
- Straps that are secured about an employee over thighs, shoulders and pelvis attached to a lanyard or other deceleration device = Body harness

5. Match the word with the correct definition.

- A conductor embedded in the earth used to maintain ground potential on conductors connected to it = Grounding electrode
- A physical device that prevents the transmission or release of energy = Energy isolating device
- The minimum distance for the use of line tools when performing live-line work = Clear hot stick distance
- A system that prevents a worker from falling from one elevation to another = Fall prevention system
- A material, usually in the form of a wire, or cable suitable for carrying an electrical current = Conductor

6. Any electrical circuit that normally operates at more than 600 volts is the _____.

Primary Voltage

7. A downhole tool that increases the diameter of a pilot bore is a _____.

backreamer

8. A high voltage test is a test in which _____.

test in which voltages of approximately 1000 volts are used as a practical minimum that also has sufficient energy to cause injury

9. A conductor or group of conductors that serves as a common connection for two or more circuits is a _____.

bus

10. Match the word with the correct definition.

- The clear distance between two object measured surface to surface = Clearance
- The entity that has jurisdiction and control over the operation = Utility
- American National Standards Institute = ANSI
- Joins a backreamer assembly to a conduit adapter and permits the backreamer to rotate = Swivel
- A compartment containing voltages greater than 600 volts = Primary Compartment

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Climbing Wooden Structures Module

Assignment: Read Chapter 44 Handbook - Climbing Wooden Poles
Read APPA Safety Manual Section 507.3 Climbing

Quiz: Climbing Wooden Structures

1. Which of the following is NOT part of the essential pole-climbing equipment.

Insulation Equipment

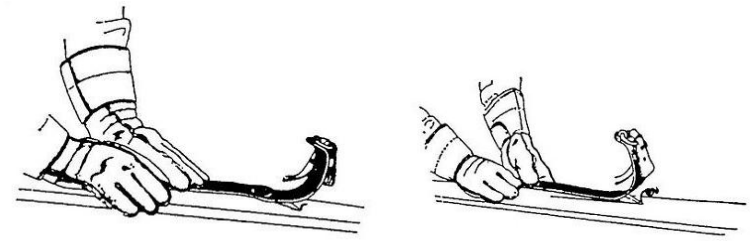
2. When climbing a pole, it is important to pull yourself up with your arms. True or False

False

3. When climbing, it is important to have the arms and legs work in coordination. In order to do this, how is this accomplished?

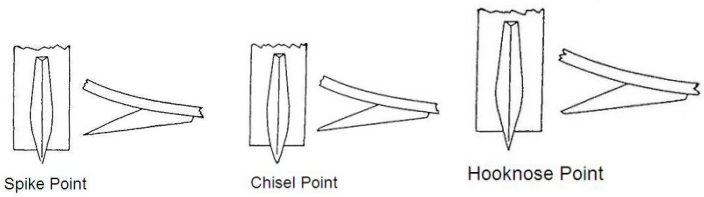
Raise right hand and right leg at the same time.

4. Select the image that correctly shows the results of a plane test.



A.

5. Select the correct way to file and shape a gaff.



Chisel Point

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6. Put in the correct order for climbing a wooden pole.

C, A, E, D, B

7. Only one person may be on a pole at a time. True or False

False

8. Select the two tests used to test a pole before climbing.

Hammer and Rocking

9. When attaching the safety strap, it is important to put it above the uppermost pole position. True or False

False

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Rigging in Powerline Work - Part 1 Module

Assignment: Chapter 17 Guidebook - Rigging in Powerline Work

PowerPoint: Rigging

Quiz: None

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Rigging in Powerline Work - Part 2 Module

Assignment: None

PowerPoint: None

Quiz: Rigging in Powerline Work

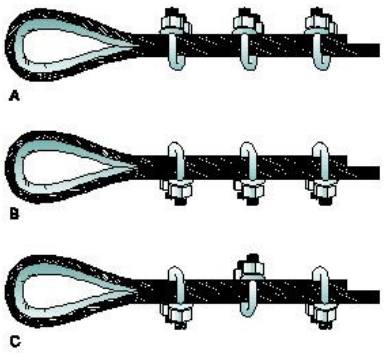
1. A working load limit for rigging components includes a [a] factor, but does not necessarily take into account the [b] of a complete rigging setup configuration.

a. safety
b. WLL

2. What is the WLL of a component that has a breaking strength of 1,000 pounds and a safety factor of 5?

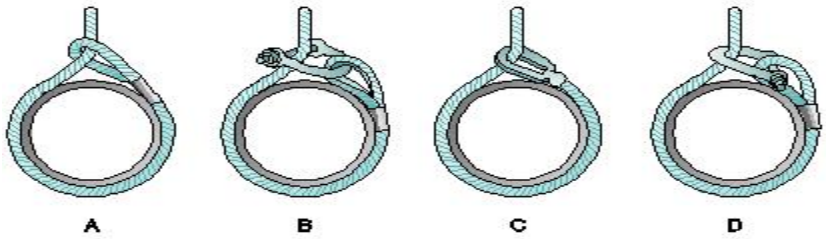
200 pounds

3. Which method is correct when installing U bolts to form a temporary eye in a wire rope?



B

4. Which methods are correct when using a choker to make a lift?



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C & D

5. The bowline is the most frequently used knot and, when not under tension, it can be untied.
True

6. Which of these knots, hitches, or bends can be untied while under tension?

Two half hitches

7. How much is the strength of a rope derated for an eye splice?

10 %

8. It is an acceptable practice to use a Chicago-type grip to temporarily hold tension on a wire rope.

False

9. If the label that identifies a nylon web sling size and rated load is missing, it is still acceptable to use the sling after a careful inspection.

False

10. If a 100 pound (50 kg) weight is being pulled up on a hand line, what is the weight supported by the hand line pulley and anchor point? The weigh to be pulled up plus the pull on a fall line add up to

200 pounds (100 kg) plus another 10% for friction.

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Basic Electrical Principles - Part 1 Module

Assignment: Chapter 2 - Guidebook - Electrical Units, Review Questions

PowerPoint: None

Quiz: None

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Basic Electrical Principles - Part 2 Module

Assignment: None

PowerPoint: None

Quiz: Electrical Units

1. What physical matter is flowing in an electrical current?

Electrons

2. A person can get into trouble when measuring voltage with a multimeter if the multimeter switch is in a position to measure resistance and a person connects the terminals to measure voltage, the meter will cause a short circuit. True or False

True

3. Why does a person normally not feel anything when hands are placed on each post of a car battery?

The potential is not high enough to overcome the resistance of a person's skin.

4. Do electrons travel at the speed of light in an electrical circuit?

No, it is the electrical charge that travels at the speed of light, not the electrons.

5. Opening a ground wire or a neutral on an energized circuit is dangerous because a ground wire or neutral can carry [a]. When the circuit is [b], the resistance across the open point is high and based on E = IR, it means that the [c] will be very high.

a. Current
b. Opened
c. Voltages

6. If a circuit is carrying 100 A, what portion of that current could induce ventricular fibrillation and probably death? A current of

100 milliamperes can cause ventricular fibrillation. Therefore, a parallel path with 1/1,000 of a 100 A circuit can cause death.

7. A [a] current feeds customer demand at the given moment; [b] current is the total current that a circuit is able to supply to a short circuit.

a. load

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b. fault

8. When an ohmmeter is hooked to two different wires and the meter reads zero, what does this indicate? It indicates that there is

No resistance between the two wires, and they must be connected together or shorted somewhere.

9. Electrical current must have a [a] in order to flow. If there is no second point of [b], there is no circuit and no current flow.

a. circuit
b. contact

10. How much current would a 240 V heater with 20 ohms resistance draw?

I = 240/20 = 12 amperes

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Linemen 1110 Midterm Module

Assignment: Complete Midterm Exam

PowerPoint: None

Exam: Midterm

1. _____ are generally made with nylon impregnated with neoprene to provide good wear resistance.

Pole straps

2. _____ should be used when walking with climbers, especially through ditches, and when storing them in a truck.

Climber guards

3. A _____ indicates that electric current has entered and exited the body and has done unknown damage to internal tissue and organs.

burn mark

4. An employee should become very familiar with _____ regulations so that there is little doubt as to his responsibilities and rights.

OSHA

5. Match the word with the correct definition.

- A rule requiring compliance by all employees and which if not, subject to disciplinary action = Safety rule
- A conductor embedded in the earth used to maintain ground potential on conductors connected to it = Grounding electrode
- A physical device that prevents the transmission or release of energy = Energy Isolating device
- The minimum distance for the use of the line tools when performing live-line work = Clear hot stick distance
- A system that prevents a worker from falling from one elevation to another = Fall Prevention System

6. Any electrical circuit that normally operates at less than 600 volts is the _____.

Secondary voltage

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7. A downhole tool that increases the diameter of a pilot bore is a _____.

Backreamer

8. A high voltage test is a _____.

Test in which voltages of approximately 1000 volts are used as a practical minimum that also has sufficient energy to cause injury

9. A conductor or group of conductors that serves as a common connection for two or more circuits is a _____.

bushing

10. Match the word with the definition.

- Straps that are secured about an employee over thighs, shoulders and pelvis attached to a lanyard or other deceleration device = Body harness
- A system that prevents a worker from falling from one elevation to another = Fall prevention system
- The minimum distance for the use of line tools performing live-line work = Clear hot stick distance
- A card or tag device that warns against the operation of a particular switch or device = Hold card

11. When climbing a pole, it is important to pull yourself up with your arms. True or False

False

12. You can wear gaffs when driving or working on the ground.

False

13. Select the correct tool to file and shape a gaff.

Gaff file, Chisel point

14. If a pole is leaning, climb on the _____ side.

high

15. What are three reasons to inspect a manhole before entering it.

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No combustible gases

16. Chain hoists are constructed with the ____ being the weakest part.

lower hook

17. The ____ splice is probably the only splice still seen in line work.

eye

18. A(n) ____ hitch is a friction hitch used to tie on to another rope to prevent it from moving or running.

taut-line

19. ____ sag refers to the sag under ice loading, wind, and temperature.

Ruling

20. The term for the combination of resistance and reactance is ____.

impedance

21. Current is measured with a(n) ____.

ammeter

22. What physical matter is flowing in an electrical current?

Electrons

23. How much current would a 240 V heater with 20 ohms resistance draw?

I = 240/20 = 12 amperes

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Electrical Power Systems Part 1 Module

Assignment: None

PowerPoint: None

Quiz: None

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Electrical Power Systems Part 2 Module

Assignment: None

PowerPoint: None

Quiz: Electrical Power Systems

1. The utilization of electrical energy comes from its four main effects. What are two of the effects electrical energy can produce?

Luminous effect, Magnetic effect

2. A wire coil moved within a [a] field is required to generate power in almost all [b] generators.

a. magnetic
b. commercial

3. Which of these common energy sources is NOT used to drive a turbine?

Fuel cells

4. Cogeneration plants are generating stations used to generate electric [a] and [b].

a. power
b. heat

5. Which of these is NOT an alternate electrical energy source?

Nuclear reactor

6. If the voltage on a transmission line could be doubled, how much energy would it be able to transmit?

The energy transmission would be quadrupled.

7. The purpose of communications systems between substations is to transmit and receive signals that operate switchgear and monitor meters and alarms remotely.

True

8. Pick three segments that make up a distribution system.

Subtransmission Circuits, Primary Feeders, Distribution Transformer

9. What is NOT an advantage of a overhead distribution system versus an underground system?

No exposure to storms, trees or accidents

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10. Name three advantages of an underground distribution system versus an overhead system.

No exposure to storms, trees, accidents, insulator breakage or contamination, More aesthically acceptable to the public, Long runs across water as submarine cable.

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Substations and Switchyards Part 1 Module

Assignment: Read Guide for Linemen and Cablemen Chapter 4 Working in Substations Pgs 114-138. Review questions pg 139.

PowerPoint: None

Quiz: Substation and Switchyards

1. Which element in a substation will automatically open a line when there is a short circuit?

Circuit breaker

2. In more urban locations, the economics of building double-bank substations or backfeeding from other substations are not options so it useful to have mobile substations to provide the backup.

False

3. There is a [a] wire mesh–type network buried underneath the gravel or concrete of a [b] substation yard into an Equipotential zone.

a. grounding
b. substation

4. The voltage and current of an incoming high-voltage transmission line is measured by using the primary transformers to show the actual voltage and current on the lines.

False

5. Anyone entering a substation should notify system control and be trained in electrical awareness or be escorted.

True

6. Select three items in a substation design that are meant to protect the public.

No gaps under the fence
No third-party metallic fence tied into station fence
The station grid extending just beyond the fence

7. It is important to open a ground connection and interrupt current, especially during a ground fault, so that the high voltage can appear between the two ends.

False

8. Which of these is NOT a use of SF6 (sulfer hexaflouride) gas?

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Fire Prevention Medium

9. When digging in an [a] station, underground hazards must be avoided by avoiding contact with [b] underground cables. It is also important to dig by hand or use a sucker truck for the first [c] feet before digging with a machine.

a. existing
b. energized
c. 5

10. What is the primary function of a switchyard?

To route electricity through various transmission lines

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Substation and Switchyards Part 2 Module

Assignment: None

PowerPoint: None

Quiz: Substations and Switchyards

1. When digging in an [a] station, underground hazards must be avoided by avoiding contact with [b] underground cables. It is also important to dig by hand or use a sucker truck for the first [c] feet before digging with a machine.

a. new
b. energized
c. 5

2. Which element in a substation will automatically open a line when there is a short circuit?

Circuit Breaker

3. In more urban locations, the economics of building double-bank substations or backfeeding from other substations are not options so it useful to have mobile substations to provide the backup.

False

4. There is a [a] wire mesh–type network buried underneath the gravel or concrete of a [b] substation yard into an Equipotential zone.

a. grounding
b. substation

5. The voltage and current of an incoming high-voltage transmission line is measured by using the primary transformers to show the actual voltage and current on the lines.

False

6. Gas insulation

No gaps under the fence
No third-party metallic fence tied into station fence
The station grid extending just beyond the fence

7. It is important to open a ground connection and interrupt current, especially during a ground fault, so that the high voltage can appear between the two ends.

False

8. Which of these is NOT a use of SF_6 (sulfer hexaflouride) gas?

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Fire prevention medium

9. The primary function of a switchyard is to rout electricity through various_____.

transmission lines

10. A line trap acts as a filter to prevent incoming communication signals from passing through the substation to other power lines and mixing with other signals.

True

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Alternating Current (AC) Concepts Part 1 Module

Assignment: Chapter 5 Alternating Current Review

PowerPoint: None

Quiz: None

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Alternating Current (AC) Concepts Part 2 Module

Assignment: None

PowerPoint: None

Quiz: Alternating Current

1. The _____ of an AC power source changes periodically.

   polarity

2. Select the three requirements for inducing a voltage.

   Conductor
   Magnetic Field
   Relative Motion

3. When a conductor rotating in a magnetic field is cutting through the maximum number of flux lines.

   Maximum voltage is induced.

4. What is the biggest advantage of AC power?

   The easy transformation from one voltage to another.

5. When a sine wave is used to represent voltage, voltage below the horizontal line is negative.

   True

6. Select the three types of loads that oppose the flow of current and form the total impedance to a circuit.

   Resistance
   Inductive Reactance
   Capacitive Reactance

7. The [a] in a circuit is monitored in a circuit to ensure that it stays [b] right from the generator to the customer.

   a. frequency
   b. constant

8. Voltage and current rises and falls from zero to peak value as it flows in one direction and then repeats the rise and fall as it travels in the other direction.

   True

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9. The number of cycles completed each second by a given AC voltage is called [a] and is measured in [b].

a. frequency
b. hertz

10. Select the three types of power in an AC circuit.

Apparent
Active
Reactive

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LINEMEN 1110 Final Module

Assignment: Complete Final Exam

PowerPoint: None

Exam: Final

1. What physical act is required to generate power in almost all commercial generators?

   A wire (coil) is moved within a magnetic field.

2. What is the advantage of a cogeneration power plant?

   Cogeneration plants are generating stations used to generate electric power and heat. The electric power can be sold to the grid, and the heat, which would otherwise be wasted heat, is sold to a central heating plant or manufacturer.

3. ____ are generally only noticed by customers who are already receiving below-normal voltage in ordinary times.

   Brownouts

4. A ____ has disconnect switches, circuit breakers, relays, and communications systems to provide circuit protection.

   switchyard

5. ____ are voltage-changing stations.

   Substations

6. Most of the electrical energy produced in the world comes from the use of _____.

   steam

7. The heat produced by electrical current is desirable for toasters, heaters, and ovens during the utilization stage, but it is wasted energy in the generation, transmission, and distribution stages is known as the ____ effect.

   thermal

8. A ____ network is used for heavily loaded downtown areas in a city.

   primary

9. ____ circuits transmit power from the large transmission substations to the distribution substations.

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Subtransmission

10. ____ has the ability to produce change or exert a force on something.

Energy

11. Which element in a substation will automatically open a line when there is a short circuit?

Circuit Breaker

12. In more urban locations, the economics of building double-bank substations or back feeding from other substations are not options so it useful to have mobile substations to provide the backup.

False

13. There is a [a] wire mesh–type network buried underneath the gravel or concrete of a [b] substation yard into an Equipotential zone.

a. grounding
b. substation

14. The voltage and current of an incoming high-voltage transmission line is measured by using the primary transformers to show the actual voltage and current on the lines.

False

15. Select three items in a substation design that are meant to protect the public.

No gaps under the fence
No third-party metallic fence tied into station fence
The station grid extending just beyond the fence

16. It is important to open a ground connection and interrupt current, especially during a ground fault, so that the high voltage can appear between the two ends.

False

17. Which of these is NOT a use of SF_6 (sulfur hexafluoride) gas?

Fire prevention medium

18. When digging in an [a] station, underground hazards must be avoided by avoiding contact with [b] underground cables. It is also important to dig by hand or use a sucker truck for the first [c] feet before digging with a machine.

a. new
b. energized
c. 5

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19. The primary function of a switchyard is to rout electricity through various_____.

transmission lines

20. The ratio of active power to apparent power is called the ____.

power factor

21. The disturbance imposed by inductive and capacitive loads in a circuit is called ____.

reactance

22. Electric load and ____ of the circuit will reduce the magnitude of the peaks and troughs over distance.

impedance

23. The ____ in a circuit stays constant right from the generator to the customer.

frequency

24. The term *cycles per second* has been replaced by the international standard term for frequency, which is ____.

hertz

25. Converters generate ____; therefore, filters must be installed to limit the effect on the AC system feeding the converters.

harmonics

26. A two-conductor DC line is referred to as a ____ circuit.

bipolar

27. The [a] in a circuit is monitored to ensure that it stays [b] right from the generator to the customer.

a. frequency
b. fluctuating

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LINEMEN - 1120 1B

	Instructional Summary
Course Description	Students will; Learn About Basic Electrical Theory, Alternating Current and Induction Principles, Basic and Advanced Transformer Concepts, Transformer Construction and Maintenance Characteristics and Operation
Student Learning Outcome	Students will; Understand Basic Electrical Theory, Be Able to Determine Efficiency of a Transformer, Explain Voltage in Conductors, Demonstrate Ability to Calculate Voltage Conversions, Read Data, Define and Calculate Turns Ration, Voltage Ratio, Effective Ratio and Current Ration
Instructional Activity	In-Class Lectures Interactive/Demo Labs Online Assignments & Assessments
Material/Equipment	Keys for Lab -Miller Campus Course Access -Canvas LMS
Duration	Course Jan 13 - May 4, 2012 (13 Weeks) Total Hours of Online Student Work (Estimate): _____ Total Hours of Online Instructor Work (Estimate): _____
Notes	Point of Contact: Online- Karma Wayman x5391 Program- Ashley Sokia x5354

(For additional details see the course syllabus.)

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Class Introduction Module

Assignment: Watch video & change your email

PowerPoint: None

Quiz: Practice

1. Which course are you taking?

    Lineman Apprentice 1A, Correct

2. You have read through the course syllabus.

    True

3. Do you have any questions for your new instructor before class begins?

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Basic Electric Theories and Principles Module

Assignment: Read Chapter 1 Transformation for Lineworkers (pgs. 1-10) - Electrical Theories and Principles

PowerPoint: None

Quiz: Basic Theories and Principles

1. In electrical circuits, what does the letter "I" represent and what is its unit of measure?

The letter I represents current and its unit of measure is the ampere or amp. (Pg. 2)

2. In electrical circuits, what is “electro motive force” and what is its unit of measure?

Electro motive force (EMF) is the voltage that causes current to flow in a complete circuit. EMF is measured in volts and is commonly referred to as voltage. (pg. 2)

3. What characteristics of a conductor determine its resistance to the flow of electrons? What is the unit of measure for resistance?

A conductor’s resistance is affected by its size (cross sectional area), length, and the type of material it is made of. It is also affected by temperature. Resistance is measured in ohms.

4. What law governs the relationship between voltage, resistance, and current? Describe how these three characteristics of a circuit are related to each other. Draw a diagram or show a formula if it helps to explain.

The law that relates voltage, resistance and current is called Ohm’s law. Ohm’s law states that the amount of current flowing through an electrical circuit is equal to the voltage across the circuit divided by the total resistance in the circuit. (pg. 3)

5. What is the voltage across a circuit if there is a total resistance of 10 ohms and a current flowing of 12 amperes?

120 volts

6. If an appliance is drawing 20 amperes from a 240 volt source, what is the resistance?

12 ohms

7. In alternating current circuits, two values are combined to form impedance. What are they?

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Impedance is a combination of resistance and reactance. Resistance, reactance, and the combined value of impedance are all measured in ohms.

8. What symbol and unit of measure is used for impedance?

Z

9. What power (in watts) is consumed by an appliance drawing 5 amps from a 120 volt source?

600 watts

10. What power (in watts) is consumed by an appliance drawing 5 amps from a 120 volt source? [a]

If this appliance operates for 10 hours, how many kilowatt-hours will it consume? [b]

a. 600 watts
b. 6 kWhr

11. What is the line-loss on a 5,000 foot conductor with a total resistance of 0.05 ohms, when a current of 100 amps flows through it? [a]

a. 500 watts

12. What is the power factor? Show an equation that can be used to calculate it. [a]
Equation: [b]

a. The ratio between true power and apparent power
b. Power factor = kW / kVA

13. A series circuit has loads of 5 ohms, 10 ohms and 15 ohms. The circuit current is 4 amps.

What is the voltage drop across each load? [a]
What is the total applied voltage? [b]
What is the current through each load? [c]
What is the total resistance? [d]

a. 20 volts, 40 volts, 60 volts
b. 120 volts
c. 4 amps
d. 30 ohms

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14. A parallel circuit has loads of 10 ohms, 20 ohms and 30 ohms. The applied voltage is 240 volts.

What is the total resistance? [a]
What is the voltage in each circuit branch? [b]
What is the current in each load? [c]
What is the total circuit current? [d]

a. 5.45 ohms
b. 240 volts
c. 24 amps, 12 amps and 8 amps
d. 44 amps

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Alternating Current and Induction Principles Module

Assignment: Read Chapter Two of Transformation for Lineworkers (17-23).

PowerPoint: None

Quiz: Alternating Current and Induction Principles

1. Describe how a voltage is induced in a conductor or coil.

   A voltage is induced when changing magnetic lines of force cut across a conductor or coil. pgs 18-19

2. Describe alternating current.

   Alternating current changes polarity twice in each cycle. In a 60 cycle system it reverses direction 120 times per second. (pg. 18)

3. No current flows in the secondary coil of a transformer when its circuit is [a]

   a. Open

4. Can a transformer work with DC (direct current)? Explain why, or why not.

   No. Relative motion is necessary for a voltage to be induced. A transformer has no moving parts and it is the changing electric field of AC that provides the necessary relative motion between the primary and secondary windings so that a voltage is induced in the secondary winding. Polarity reversal of AC causes lines of force to expand and collapse and in so doing, the lines of force cut across the stationary secondary winding. (pgs. 18-21)

5. List three ways you could increase the strength of a magnetic field.

   a. current in the windings
   b. number of windings
   c. permeability of the core

6. Are magnetic lines of force more dense in air or in iron?

   iron

7. How is voltage induced in a conductor?

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Magnetic lines of force cutting the conductor

8. What produces a magnetic field around a conductor?

Current Flow

9. Describe the principles of 60 hertz alternating current.

An alternating current generating at a frequency of 60 hertz increases and decreases in value 120 times per second. The current also reverses its direction 120 times per second.

10. The magnetic effect of an energized coil may be greatly intensified by the use of an [a] (two words) which has the ability to concentrate and direct the lines of force or magnetic field.

a. iron core

11. Once voltage is induced in a conductor, what else is required before current will flow?

The circuit must be complete or closed before current will flow.

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Transformers Module

Assignment: Read Chapter Three Transformation for Lineworkers (pgs. 17-23). Read Chapter 14 - The Purpose of a Transformer Review Questions

PowerPoint: None

Quiz: Transformers, The Purpose of Transformers

Transformers Quiz

1. The winding on the input side of the transformer is called the _____ winding.

   Primary

2. The winding on the output side of the transformer is called the _____ winding.

   Secondary

3. Transformers between the generation station and local distribution primary circuits are called _____ transformers?

   power

4. Transformers along the distribution primary circuits and at the customer's property are called _____ transformers?

   Distribution

5. Why is voltage stepped up, before transmitting it over long distances?

   Stepping up the voltage allows the utility to transmit a given amount of power with a lower current. This allows use of smaller conductors and also reduces power losses (line losses). (pg. 30)

6. What is the percent efficiency of a transformer if 6,500 watts are input, and 6,350 watts are output?

   98 %

7. Whether the transformer is additive or subtractive is based on the ____ of the coil winding.

   direction

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8. The terminals of a transformer have a fixed _____ in relation to other terminals.

Polarity

9. Distribution transformers with taps typically have tap settings that raise or lower voltage _____% for each tap.

2.5

10. The transformer ratio is calculated using the equation _____

input/output = transformer ratio

The Purpose of Transformers Quiz

1. The transformer ratio is calculated using the equation _____.

input/output = transformer ratio

2. Distribution transformers with taps typically have tap settings that raise or lower the voltage ____% for each tap.

2.5

3. Whether the transformer is additive or subtractive is based on the ____ of the coil winding.

direction

4. The terminals of a transformer have a fixed ____ in relation to other terminals.

polarity

5. A ____ test will ensure that there are no shorts between turns in the windings.

ratio

6. Regardless of the turns ratio, and ignoring some transformer losses, the energy input into the transformer is ____.

equal to the energy output

7. A ____ is an electromagnetic device that provides a magnetic linkage between two electrical circuits.

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transformer

8. When a single-wire earth return (SWER) system is feeding a transformer, then the pole/down ground is the primary ____.

neutral

9. Ferroresonance can cause the voltage on a circuit to increase from two to ____ times, causing equipment damage.

nine

10. When the primary of the transformer is opened, the primary terminal will remain energized because of ____ from the energized secondary.

backfeed

11. ____ are high-capacity fuses designed and fused to blow before the cable insulation is damaged by heat from excessive current feeding a fault.

Limiters

12. In the American system, one three-phase transformer is used to feed about ____ times the length of a typical single-phase secondary bus for a given load and for the same voltage drop limitation.

eight

13. The ____ transformer is used to reduce the voltage on local distribution lines to a utilization voltage.

distribution

14. Most people worldwide use the ____ distribution system to feed utilization voltages to the customers.

European

15. A ____ is a tapped autotransformer that can regulate voltage under loaded conditions.

voltage regulator

16. ____ transformers are potential transformers and current transformers that reduce voltage and current to lower, manageable levels.

Grounding

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17. A ____ transformer is used as an indirect way to ground one phase of a delta circuit.

Grounding

18. A ____ transformer is one that is used where telecommunications (telephone) cable enters a substation.

neutralizing

19. A three-phase service supplied to a customer should not have a voltage imbalance exceeding ____%.

1

20. When two or more transformers are connected in a(n) ____ configuration, the coils are connected in series with each other.

delta

21. A ground wire is a ____

grounding conductor

22. The ____ ratio of a transformer determines the ratio between the primary voltage and the secondary voltage.

turns

23. When single-phase transformers are to be connected in parallel or connected into a three-phase bank, it is normal to select transformers with the same ____.

polarity

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Transformer Construction Module

Assignment: Read Chapter 4 Transformation for Lineworkers

PowerPoint: None

Quiz: Transformer Construction

1. What is the formula that shows the relationship between exciting current and its two components.

Since iron loss and magnetizing currents are 90 degrees out of phase from each other the total current is the vector sum of their values. (pg. 43)

2. In a transformer, is the high-voltage or low-voltage winding usually located closest to the core?

The low-voltage winding is located closest to the core and the high voltage winding is usually furthest from the core. This avoids flashover. (pg. 37)

3. Why is it desirable to reduce eddy currents?

Eddy currents reduce the efficiency of transformers.

4. How are transformer cores constructed, so as to reduce eddy currents?

To reduce eddy currents, transformer cores are made from steel laminations which are separated by paper-thin layers of insulation. The thinner the steel laminations, the smaller the eddy currents, and the better the efficiency of the transformer. (pg. 38)

5. What is “copper loss”?

Copper loss refers to the loss in a transformer due to the resistance in the primary and secondary windings. This loss is equal to the square of the current, times the resistance of the windings and is expressed in watts. Copper loss is zero at no load, and a maximum at full load. (pg. 42)

6. Describe features designed into transformers to keep them cool.

Most transformers are filled with oil which transfers heat from the core and internal conductors to the outer walls. Cooling fins attached to the outer walls increase the surface area with outside air. Cooling tubes circulate oil near the internal windings which is then cooled outside the tank. In substations, radiators attached to transformer walls expand the surface area available for cooling. Large transformers have fans to blow cooling air across the radiators. Very large transformers use pumps to circulate oil or water running through coils in the tank and outside through cooling fins or radiators. (pg. 44)

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7. Name three components common to all distribution transformers.

    a. Primary coil
    b. Secondary Coil
    c. iron core

8. Why are bushings used on transformers?

    Bushings allow leads to enter and exit the tank without shorting to the grounded tank case.(pg. 42)

9. What is “core loss”?

    Core loss refers to the losses in a transformer due to eddy currents flowing in the windings, and to the hysteresis loss due to “flipping” the magnetic molecules as they are first magnetized in one direction, then in the other direction. (pg. 43)

10. What is exciting current?

    Exciting current is the current through the primary, when there is no load on the secondary.

11. What are the two components of exciting current?

    a. iron loss current or magnetizing current

12. What is “transformer regulation”?

    Transformer regulation refers to the voltage difference between the no-load and full-load secondary voltage. (pgs. 43 and 44)

13. How do you determine the percent regulation of a transformer? Show the formula.

    Measure the secondary voltage under full load and also under no load. Calculate the percent difference using the following formula: % regulation = (no voltage volts - full load volts) divided by (full load volts) multiplied by 100. (pg. 44)

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Transformer Information, Characteristics Module

Assignment: Read Chapter 5 - Transformation for Lineworkers

PowerPoint: None

Quiz: Transformer Information

1. On subtractive 3-bushing transformers the internal secondary winding leads are marked D, C, B, A left-to-right and the secondary bushings are X1, X2 and X3 left-to-right. Identify the letter lead(s) you would connect to each bushing for a series operation. [a]
Identify the letter leads you would connect to each bushing for a parallel operation. [b]
In b) above, what would happen if you accidentally connected AB to X2 and CD to X1? [c]

    a. D to X1, CB to X2 and A to X3.
    b. BD to X1, AC to X2 and none to X3.
    c. The winding would be short circuited --- DO NOT ENERGIZE!

2. Why is kVA used instead of kW when calculating the capacity of a transformer?

    Transformer capacity is rated in kVA, not kW, because it represents the full load delivered by the transformer. (pg. 61)

3. On a transformer nameplate, what is meant when voltages are separated by a slash (/)?

    Voltages separated by a slash (/) means both voltages are available on the secondary but not on the primary, e.g., on page 56.

4. On a transformer nameplate, what is meant when voltages are separated by an X?

    Voltages separated by an X means both voltages are possible, but not at the same time.

5. On a transformer nameplate, what is meant when voltages are separated by a dash (-)?

    Voltages separated by a dash (–) indicates that one side is the primary voltage, and the other side is the secondary voltage. (pg. 52)

6. List at least four items of information you can find on a transformer nameplate. (pg. 53)

    [a] Rated high and low voltages

    Rated kVA capacity

    High voltage tap connections and diagram

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Low voltage connections (series and parallel)

Polarity

Name of manufacturer

Serial number

Type (oil or liquid filled)

Line frequency

Weight (including oil or other liquid)Gallons of oil or other liquid Insulated (or not) for wye connection Percent impedance

Temperature rise at 55°C

7. When wiring a single-bushing transformer, where does the H2 lead connect?

The H2 primary lead is tied to the secondary winding center point (common or neutral) which in turn is bonded to the transformer case. On a single-bushing transformer, the H2 lead does not come out to a high-voltage bushing. (pg. 56)

8. The connections between the primary bushings and internal transformer windings. can be changed in the field. True or False

False

9. The connections between the secondary bushings and internal transformer windings, can be changed in the field. True or False

True

10. List two situations in which you might want to parallel the secondary windings of distribution transformer.

For long term parallel operation of two transformers in place of a larger transformer when one is not available. Where 120 volts two-wire single phase is required at full transformer capacity. (pg. 57) To establish a 120/208 volt three-phase four-wire wye-connected secondary using three transformers.

11. Most distribution transformers are _____ polarity.

additive

12. The voltage of two coils connected in series is [a] _____ times the voltage of one coil. The current available when two coils are connected in parallel is [b] _____ times the current capacity of one coil.

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a. 2
b. 2

13. On an additive 7200–120/240 volt 4-bushing transformer, describe how you would connect the secondary windings for:
Series operation to provide 120/240 volt service at full capacity. [a]
Parallel operation 120 volt service at full capacity. [b]
In b) above, what would happen if you accidentally connected X1 to X2 externally and X3 to X4 externally? [c]

a. Connect X2 to X3 externally and proceed with standard connections to the secondary.
b. Connect X1 to X3 externally and connect X2 to X4 externally, then proceed with standard connections to the secondary
c. Each winding would be short circuited --- DO NOT ENERGIZE!

14. A 100 kVA, 14,400–120/240 volt transformer is loaded 100%. What is the secondary current when;
The windings are in series at 240 volts? [a]
The windings are in parallel at 120 volts? [b]

a. 416.6 or 417 amps
b. 833 amps

15. All transformers with a 7200 volt primary winding may be wyeconnected to a 7200/12,470 volt primary circuit.

False

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Transformer Operation Module

Assignment: Read Chapter Six - Transformation for Lineworkers

PowerPoint: None

Quiz: Transformation Operation

1. By what principle does the primary winding of an energized transformer induce a voltage in the secondary winding?

electromagnetic induction

2. A small current flows in the primary winding of an unloaded transformer. It is called the _____ (two words).

Exciting Current

3. The exciting current in a transformer has two parts. The second part is 90 degrees behind the impressed voltage and supplies the _____ (two words).

Magnetizing current

4. The magnetizing current in a transformer produces a _____.

Flux

5. The flux lines of force cut across the primary winding of a transformer and induce a _____ (two words) in the winding which is nearly equal to the applied voltage.

Counter voltage

6. The counter voltage is in the [a] _____ direction to the applied voltage and nearly [b]_____ in value.

a. Opposite
b. Equal

7. The resistance in the primary winding is very low and so the transformer has to depend on the [a] _____ to [b] _____ the current flow and thus avoid burnout.

a. Counter voltage
b. Limit

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8. What characteristic of a transformer determines the ratio of the primary voltage to the secondary voltage?

The ratio of the number of turns on the primary winding, to the number of turns on the secondary winding.

9. If the primary of a transformer measures 7.2 kV with 5 amps of current, and the secondary measures 240 volts, how much current is flowing in the secondary?

- Secondary current = (primary current x primary voltage) / secondary voltage (pg. 71)
- Secondary current = (5 amps x 7,200 volts) / 240 volts = 150 amps.
- Alternate method: Voltage ratio is 30:1 and current ratio is 1:30. Therefore, the primary current (5 amps) x 30 = secondary current (150 amps). (pg. 72)

10. Define turns ratio.

The ratio of the number of turns in the primary winding to the number of turns in the secondary winding.

11. Define voltage ratio

The ratio of the primary voltage to the secondary voltage.

12. Define effective ratio.

The ratio of input voltage to output voltage irrespective of how multiple windings may be connected, i.e. series or parallel.

13. Define current ratio.

The ratio of the primary current to the secondary current. It is the inverse ratio of the voltage ratio.

14. A 50 kVA, 7,200 x 14,400 – 120/240 volt transformer provides the following connection options by using series and/or parallel winding arrangements.

14,400 – 120/240 volts: Effective voltage ratio is 60:1. Effective current ratio is [a]

14,400 – 120 volts: Effective voltage ratio is 120:1. Effective current ratio is [b]

7200 – 120/240 volts: Effective voltage ratio is [c]. Effective current ratio is 1:30.

7200 – 120 volts: Effective voltage ratio is 60:1. Effective current ratio is [d]

In the foregoing examples, windings were used in either series or parallel configurations.

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In each installation, the [e] ratios did not change but the [f] ratios did.

a. 1:60.
b. 1:120
c. 30:1
d. 1:60
e. turns
f. effective

15. The primary voltage is low at the end of a circuit. A transformer is equipped with a tap-changer. To raise the secondary voltage would you increase or decrease the effective ratio with the tap-changer? [a]

a. Decrease

16. If the nominal voltage the utility supplies a cusotmer is 240 volts, what voltage variation is typically allowed?

From 210 to 260 volts

17. Why is a tap-changing mechanism is built into some transformers?

To be able to change the secondary voltage up or down in order to deliver the correct voltage to customers.

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Linemen 1120 Midterm Module

Assignment: Complete Midterm Exam

PowerPoint: None

Exam: Midterm

1. Describe how a voltage is induced in a conductor or coil.

   A voltage is induced when changing magnetic lines of force cut across a conductor or coil.

2. Describe alternating current.

   Alternating current changes polarity twice in each cycle. In a 60 cycle system it reverses direction 120 times per second. (Pg. 18)

3. In electrical circuits, what does the letter "I" represent and what is its unit of measure?

   The letter "I" represents current and its unit of measure is the ampere or amp.

4. What is the voltage across a circuit if there is a total resistance of 10 ohms and a current flowing of 12 amperes?

   120 volts

5. What symbol and unit of measure is used for impedance?

   Z

6. What power (in watts) is consumed by an appliance drawing 5 amps from a 120 volt source? [a] If this appliance operates for 10 hours, how many kilowatt-hours will it consume? [b]

   a. 600 watts
   b. 6 KWhr

7. The transformer ratio is calculated using the equation _____.

   input/output = transformer ratio

8. The power carried in a circuit is equal to _____.

   volts x amperes

9. Distribution transformers with taps typically have tap settings that raise or lower the voltage ____% for each tap.

   2.5

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10. Whether the transformer is additive or subtractive is based on the ____ of the coil winding.

direction

11. Ferro resonance can cause the voltage on a circuit to increase from two to ____ times, causing equipment damage.

nine

12. A ____ is a tapped autotransformer that can regulate voltage under loaded conditions.

voltage regulator

13. A three-phase service supplied to a customer should not have a voltage imbalance exceeding ____%.

1

14. The winding on the input side of the transformer is called the _____ winding.

Primary

15. Transformers between the generation station and local distribution primary circuits are called _____ transformers?

Power

16. Why is voltage stepped up, before transmitting it over long distances?

Stepping up the voltage allows the utility to transmit a given amount of power with a lower current. This allows use of smaller conductors and also reduces power losses (line losses). (pg. 30)

18. Describe features designed into transformers to keep them cool.

Most transformers are filled with oil which transfers heat from the core and internal conductors to the outer walls. Cooling fins attached to the outer walls increase the surface area with outside air. Cooling tubes circulate oil near the internal windings which is then cooled outside the tank. In substations, radiators attached to transformer walls expand the surface area available for cooling. Large transformers have fans to blow cooling air across the radiators. Very large transformers use pumps to circulate oil or water running through coils in the tank and outside through cooling fins or radiators. (pg. 44)

19. Name three components common to all distribution transformers.

a. Primary coil
b. Secondary coil
c. iron core

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20. What is exciting current?

Exciting current is the current through the primary, when there is no load on the secondary.

21. Why is kVA used instead of kW when calculating the capacity of a transformer?

Transformer capacity is rated in kVA, not kW, because it represents the full load delivered by the transformer. (pg. 61)

22. List two situations in which you might want to parallel the secondary windings of distribution transformer.

For long term parallel operation of two transformers in place of a larger transformer when one is not available.

Where 120 volts two-wire single phase is required at full transformer capacity. (pg. 57)
To establish a 120/208 volt three-phase four-wire wye-connected secondary using three transformers.

23. A 100 kVA, 14,400–120/240 volt transformer is loaded 100%. What is the secondary current when;
The windings are in series at 240 volts? [a]
The windings are in parallel at 120 volts? [b]

a. 416.6 or 417 amps.
b. 833 amps

24. The counter voltage is in the [a] _____ direction to the applied voltage and nearly [b]_____ in value.

a. Opposite
b. Equal

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Polarity of Transformers Module

Assignment: Read Chapter 7 (pgs. 87-92) in Transformation for Lineworkers and complete review questions beginning on page 93.

PowerPoint: None

Quiz: Polarity of Transformers

1. In a transformer with additive polarity, currents in the primary and secondary windings, flow in the [a] direction. In a transformer with subtractive polarity, currents in the primary and secondary windings, flow in the [b] direction.

    a. same
    b. opposite pg. 88

2. The instantaneous polarity relationship between H1 and X1 of transformers is:

    Always the same, Pg. 88

3. Most distribution transformers usually have _____ polarity.

    additive, Pg. 88

4. Large power transformer usually have _____ polarity.

    subtractive, Pg. 89

5. Single-phase transformers below 200 kVA are usually manufactured with [a] polarity. Transformers above [b] kVA are usually manufactured with [c] polarity.

    a. additive
    b. 200
    c. subtractive, Pg. 89

6. If both winding are wound around the same core and in the same direction, their polarity will be [a] . If wound in opposition directions, their polarities will be [b]

    a. subtractive
    b. additive, Pg. 89

7. List one situation in which you do not need to know the polarity of a transformer.

    When hooking up one single-phase transformer to deliver a single-phase service.

8. Name one situation in which you must know the polarity of a transformer.

    When interconnecting single-phase transformer in a bank. When paralleling two transformers for increased capacity.

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9. When conducting a polarity test, if the applied test voltage is 120 volts, the primary test voltage will be:

A few volts higher or lower than 120 volts, Pg. 92

10. When installing a single-phase transformer in a three-phase bank:

Confirm the polarity using a voltmeter, if necessary.
Check the polarity indicated on the nameplate.

11. When conducting a polarity test, the test voltage (typically 120 volts) is applied across the:

High voltage winding

12. If 120 volts were applied across the low voltage terminals of a transformer during a polarity test, a very high voltage would occur across the high voltage terminals and seriously endanger anyone present.

True

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Tap Changers and Operation Module

Assignment: Read chapter 8 in Transformation for Lineworkers (pgs. 95-102). Complete review questions on page 103.

PowerPoint: None

Quiz: Tap Changers

1. How are taps changed on a tap changer with a terminal board?
   Change the connections made by copper links (straps) which tie the terminals on the terminals on the terminal board together.

2. How are taps changed on a tap changer with a switch?

   Rotate the switch inside the transformer case. The switch extends up out of the oil.

3. How many switch positions are there on most tap changers?

   4, four

4. What is the percent difference in primary voltage, between each tap setting?

   4-1/2%, Pgs. 96-101

5. When installing a transformer, unless otherwise directed, what setting should a tap charger be set at?

   100%

6. Before putting your hands into transformer oil, what chemical, which is no longer permitted in new transformers, should you check for?

   PCBs, Pg. 101

7. When changing a terminal setting, what precaution can you take to avoid accidentally dropping a tool into the bottom of the oil-filled tank?

   Tie your wrench, or any other tool you are using, to a short piece of cord to be able to retrieve it if dropped.

8. The taps on a tap-changer may be changed while the transformer is energized.

   False

9. What are the primary and secondary voltages of the most common dual-voltage transformers?

   14,400 x 7,200 volts - 120/240 volts, Pg. 100

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10. A dual-voltage transformer rated at 14,400 x 7,200 - 120/240 volts was installed and energized at 7,200 volts. The dual-voltage switch was overlooked and remained at the 14,400 volt setting. What are the output voltages?

240/480 volts instead of the required 120/240 volts, Pg. 100

11. Name one advantage of primary dual-voltage transformers.

They can be used on two different primary voltages, so the electrical utility can inventory fewer transformers. (pg. 99) They can be installed in the field where a future voltage conversion is likely. During the conversion, the primary dual voltage switch allows the same transformer to accommodate the new voltage. This feature allows service to be restored much faster and avoids change of a large number of transformers. (pg. 102)

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Install Transformers Module

Assignment: Read chapter 9 in Transformation for Lineworkers (pgs. 105-114). Complete review questions on pages 115 and 116.

PowerPoint: None

Quiz: Install Transformers

1. Explain the differences between the transformer voltage labeling 120/240, 240/120, and 120 X 240?

120/240 means that the two secondary windings may be connected in parallel for full kVA at 120 volts, in series for full kVA at 240 volts, or in center-tapped series to supply 120 and 240 volts at the same time. 240/120 means that the two sections are permanently connected in center-tapped series. They cannot be connected in parallel. 120 X 240 means that the sections may be connected in either parallel or series but are not suitable for center-tapped service. (pg. 106)

2. If a transformer is labeled as 14,400/24,940 Y, what does this say about its H2 end and what connections is the transformer is suited for? If instead it says 24,940 Grd Y/14,400, how is the H2 end different and what connection is necessary?

14,400/24,940 Y means the transformer is suitable for delta connection, having full insulation of the H2 end. If a transformer was ordered 24,940 Grd Y/14,400, the transformer would have reduced insulation at the H2 end which must be tied to the system neutral). (pg. 106)

3. What does ONAN stand for?

Oil, Natural cooling, Air, Natural cooling. Pg. 106

4. How should drop leads be arranged (located) to be as safe as possible?

Drop leads should be located so that side sway caused by wind will not cause contact with any other object. Excessive length or curly risers should be avoided as they are hazardous. pg. 106

5. How may a single customer's aluminum triplex be directly connected to a transformer?

For transformers with clamp or basket terminals, splice a length of copper to the aluminum. For transformers with spade terminals, connect a spade lug to the aluminum conductor, and bolt it to the terminal. (pg. 107)

6. When is it appropriate to use aluminum drop leads instead of copper and what size should they be compared to the copper alternative?

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All drop leads are weatherproof copper except transformers with aluminum spade terminals may use aluminum leads one size larger. (pg. 107)

7. Why is it a good idea to position the lower transformer mounting bolts a bit further away from the top bolts than the holes in the mounting bracket and how much further apart should they be?

To provide better stability the bolts to which the transformers are mounted should be spaced approximately 3/8 inch further apart vertically than the corresponding bracket spacing to ensure that the weight is carried by the top bolt only. (pg. 108)

8. When using a basket terminal to connect a drop lead to the transformer bushing, how should the copper lead be fed into the basket? Explain one advantage of this method.

The conductor should be looped over the top then into the basked from above. This is to prevent water from getting into the connection. Water between dissimilar metals causes oxides to form creating an intermittent connection. (pg. 111)

9. What type of wire should be used for neutral drop?

#4 copper wire
Answer Text
Pg 113

10. What does C.G.N stand for?

Common Grounded Neutral

11. When might a CGN configuration be used?

some wye-wye systems
With a C.G.N. the neutral is common to both the primary and secondary and is grounded at regular intervals. (pg. 114)

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Single-phase Transformer Connections - Part 1 Module

Assignment: Complete review questions on pages 129-130 in Transformation for Lineworkers.

PowerPoint: None

Quiz: None

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Single-phase Transformer Connections - Part 2 Module

Assignment: Complete review questions on pages 129-130 in Transformation for Lineworkers.

PowerPoint: None

Quiz: Single-phase Transformer

1. What is the most common distribution transformer that is used in residential areas?

   Two bushing, single-phase
   120/240 volt transformer

2. What is the first step when preparing to temporarily parallel a newly installed distribution transformer with an existing secondary?

   Complete all ground and neutral connections of new installation. (pg. 122)

3. What is the last step before connecting drop leads to phases when temporarily paralleling distribution transformers? Why is this step always necessary?

   Before connecting drop leads, the phases have to be positively identified. It is important to check for voltage between conductors before paralleling since matching external wiring doesn't rule out differences in internal connections. (pg. 122)

4. What are some disadvantages of wiring a second transformer identically in parallel with an existing overloaded transformer to supply single-phase service for the long term?

   One disadvantage of this configuration is that two smaller transformers have more losses than one larger replacement transformer. Another disadvantage is if one transformer fails the remaining transformer could be overloaded and burn out. (pg. 123)

5. List three advantages of parallel the second winding internally in each transformer before connecting them into long-term parallel installation.

   If one transformer fails, the customer still has partial service at 120 volts but knows something is wrong and will notify the utility. If one transformer fails then the remaining transformer is not overloaded. It maintains only its own 120 volt load. Each transformer is fused individually as per its kVA rating. (pg. 124)

6. Why is it necessary to connect hot legs of opposite instantaneous polarity to lines A and B in the recommended long term parallel wiring configuration?

   To provide 240 volt single-phase service between lines A and B. If the secondary risers of each transformer were not opposite each other then the voltage between lines A and B would be 0 (zero). The installation would only provide N to A = 120 volts, N to B = 120 volts and A to B would be 0 volts. (pg. 124)

7. How is backfeed in a long term parallel?

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Backfeed is possible from one transformer to the other through any 240-volt connected load. (pg. 125)

8. When mounting a second transformer on a pole, how many degrees apart and how many inches above or below should it be from the first one?

A second transformer should be mounted 135 degrees around the pole and 4 inches below the original transformer. (pg. 126)

9. If you have a 14.4 kV primary and only 7.2 kV transformers how could you connect two transformers to supply residential service at 120/240 volt service?

You could connect the primary side of the two 7.2 kV transformers in series, then parallel the secondaries to provide normal residential service. The impedances of the transformers must be matched. (pg. 127)

10. Define backfeed.

Transformer backfeed occurs when it is energized by the secondary it is connected to. This can be very dangerous because such energization may be unexpected and unknown.

11. When could you unexpectedly run into backfeed?

Transformer backfeed occurs when it is energized by the secondary it is connected to. This can be very dangerous because such energization may be unexpected and unknown.

12. When could you unexpectedly run into backfeed?

A transformer could be backfed by the secondary circuit which is energized by another transformer. This could happen if secondary cuts between the two transformers had been jumpered across during a previous case of trouble in the area but the jumpers had never been removed. When restoring power, backfeed could also be caused by a temporary generator attached to a customer's circuit. Evaluate other answers individually. (pg. 128) 31

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Conduct Transformer Load Checks Module

Assignment: Read chapter 11 in Transformation for Lineworkers (pages 133-137). Complete self-test on pages 138-139.

PowerPoint: None

Quiz: Conduct Transformer

1. The current readings on the secondary side of a 100 kVA, 14,400 - 120/240 volt transformer are A leg = 535 amps and B leg = 285 amps. What is the kVA load on A winding, B winding and the total transformer? Is the transformer overloaded?

(535 x 120) / 1,000 = 64.2 kVA. The total transformer load is under 100 kVA so it is not overloaded. The load on A winding is over 50 kVA and it is overloaded. Some of the A phase load can be transferred to B phase to protect the transformer. (pg. 137)

2. Why are transformer load checks performed?

Transformer load tests are performed to determine when transformers are overloaded. They are also used when adding new loads, customers, etc., to a transformer. (pg. 134)

3. Short transformer overload peaks of up to [a] _____ minutes do not affect the transformer; however, concern should be given to the peaks averaging [b] _____ minutes or more.

a. 5
b. 20

4. Why is it difficult to get a reliable reading with a clip-on ammeter?

It's difficult to get a reliable reading with a clip-on ammeter because you might miss the peak load of the day.

5. What time of day should a clip-on ammeter be used to produce the best results?

Ammeter readings should be taken when the load is considered at the highest peak. (pg. 134)

6. Why are Maximeters better at capturing the highest loads on a transformer?

As compared to instantaneous load checks with clamp-on ammeters. Maximeters are installed for long time periods and are able to record the highest load seen during the test. (pg. 134)

7. To protect yourself and the Maximeter you should never change the [a] _____ while the meter is clamped around the conductor. You should also change the [b] _____ to the highest scale when finished.

a. tap

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b. tap

8. What is the formula for calculating the total load on a transformer?

Load in kVA = [sum of phase currents x voltage (line to neutral)] / 1,000 (pg. 136)

9. What is the total load in kVA on a transformer that has a secondary drawing 75 amps on A leg and 100 amps on B leg when the secondary voltage is 120/240?

Load in kVA = [(75 + 100 amps) x 120 volts] / 1,000 = 21 kVA (pg. 136)

10. Why is it best to measure the load on each winding separately before combining winding loads to determine the total load?

It is best to check winding loads separately because although a transformer may record a safe total load it may be unbalanced with one winding seriously overloaded.

11. A transformer is found to be unbalanced and overloaded on one winding. Why should it be corrected and how can you do so?

Correcting this problem could avoid a transformer burnout, save the cost of a transformer upgrade and would improve voltage regulation. Load balance problems can often be corrected by swapping some service drip leads. (pg. 137)

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Energize Transformers Safely Module

Assignment: Read chapter 12 in Transformation for Lineworkers (pages 143-145).
Study self-test questions for final exam.

PowerPoint: None

Quiz: Energize Transformers Safely

1. List at least three things to check on a transformer when looking for signs of overheating.

   bulged tank, discolored paint, smell of burnt oil, bulged, discolored, burnt oil

2. List at least four things that can cause a protective fuse to trip.

   lightening
   short circuit from birds
   bare secondary
   wrapped secondary

3. Explain why it is always necessary to remove the secondary connections before performing hand work on a transformer.

   It is important to remove the secondary connections because a transformer that is disconnected from its normal source may still be back-fed (energized) from another source via the secondary and dangerous voltage may exist at the primary terminals. (pg. 144)

4. List at least three things you should check for when inspecting the primary, secondary and ground leads at a transformer installation.

   proper connections
   proper clearance
   wire size
   size of damage
   wiring size
   signs of damage

5. Why would you want to estimate the transformer load before reconnecting?

   to rule out serious overload as a source of failure. Pg. 144

6. List at least three things you should check for when inspecting the secondary conductors?

   secondary conductors for damaged bushings
   bare connectors (damaged insulation)
   wrapped uninsulated conductors
   loose connections Pg. 144

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7. If damage is found, you should repair or replace damaged equipment before re-energizing a transformer.

True

8. Why is it unsafe to energize a transformer from a pole? List at least three safe options for energizing a transformer.

It is unsafe to energize a transformer from the pole because an unknown fault can occur which can cause a violent explosion and cause injury. You can safely energize from a remote device, such as an upstream disconnect switch. You can close the transformer's disconnect using a P2 fusing stick or grip-all from a safely positioned, aerial lift bucket at least 10 horizontal feet from the transformer being energized. You can use a telescopic hot stick equipped with a P2 attachment from a safe position on the ground. (pg. 144)

9. What two things should you check after energizing a transformer?

Take voltage readings to confirm proper service voltage and take load readings when connecting large unknown loads to ensure that the transformer is of adequate size for the connected load. Pg 145

10. Why is it difficult to close a disconnect with a telescoping hot stick?

It tends to wobble when extended pg. 145

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LINEMEN 1120 Final Module

Assignment: Complete Final Exam

PowerPoint: None

Exam: Final

1. In a transformer with additive polarity, currents in the primary and secondary windings, flow in the [a] direction. In a transformer with subtractive polarity, currents in the primary and secondary windings, flow in the [b] direction.

a. same
b. opposite Pg. 88

2. Most distribution transformers usually have _____ polarity

subtractive Pg. 89

3. Large power transformer usually have _____ polarity.

subtractive Pg. 89

4. If 120 volts were applied across the low voltage terminals of a transformer during a polarity test, a very high voltage would occur across the high voltage terminals and seriously endanger anyone present.

True Pg. 92

5. Before putting your hands into transformer oil, what chemical, which is no longer permitted in new transformers, should you check for?

PCBs Pg. 101

6. When changing a terminal setting, what precaution can you take to avoid accidentally dropping a tool into the bottom of the oil-filled tank?

Tie your wrench, or any other tool you are using, to a short piece of cord to be able to retrieve it if dropped.

7. How should drop leads be arranged (located) to be as safe as possible?

Drop leads should be located so that side sway caused by wind will not cause contact with any other object. Excessive length or curly risers should be avoided as they are hazardous. pg. 106

8. Why is it a good idea to position the lower transformer mounting bolts a bit further away from the top bolts than the holes in the mounting bracket and how much further apart should they be?

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To provide better stability the bolts to which the transformers are mounted should be spaced approximately 3/8 inch further apart vertically than the corresponding bracket spacing to ensure that the weight is carried by the top bolt only. (pg. 108)

9. What is the most common distribution transformer that is used in residential areas?

Two bushing, single-phase, 120/240 volt transformer. (pg. 121)

10. What is the first step when preparing to temporarily parallel a newly installed distribution transformer with an existing secondary?

Complete all ground and neutral connections of new installation. (pg. 122)

11. How is backfeed in a long term parallel?

Backfeed is possible from one transformer to the other through any 240-volt connected load. (pg. 125)

12. Define backfeed.

Transformer backfeed occurs when it is energized by the secondary it is connected to. This can be very dangerous because such energization may be unexpected and unknown.

13. When could you unexpectedly run into backfeed?

A transformer could be backfeed by the secondary circuit which is energized by another transformer. This could happen if secondary cuts between the two transformers had been jumpered across during a previous case of trouble in the area but the jumpers had never been removed. When restoring power, backfeed could also be caused by a temporary generator attached to a customer's circuit. Evaluate other answers individually. (pg. 128)

14. The current readings on the secondary side of a 100 kVA, 14,400 - 120/240 volt transformer are A leg = 535 amps and B leg = 285 amps. What is the kVA load on A winding, B winding and the total transformer? Is the transformer overloaded?

a. (535 x 120) / 1,000 = 64.2 kVA.

b. (285 x 120) / 1,000 = 34.2 kVA

c. 64.2 kVA + 34.2 kVA = 98.4 kVA

The total transformer load is under 100 kVA so it is not overloaded. The load on A winding is over 50 kVA and it is overloaded. Some of the A phase load can be transferred to B phase to protect the transformer. (pg. 137)

15. What is the formula for calculating the total load on a transformer?

Load in kVA = [sum of phase currents x voltage (line to neutral)] / 1,000 (pg. 136)

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16. A transformer is found to be unbalanced and overloaded on one winding. Why should it be corrected and how can you do so?

Correcting this problem could avoid a transformer burnout, save the cost of a transformer upgrade and would improve voltage regulation. Load balance problems can often be corrected by swapping some service drip leads. (pg. 137)

17. List at least three things to check on a transformer when looking for signs of overheating.

bulged, discolored, burnt oil, bulged tank, discolored paint, smell of burnt oil

18. List at least three things you should check for when inspecting the primary, secondary and ground leads at a transformer installation.

proper connections
proper clearance
wire size
size of damage

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LINEMEN - 1210 2A

	Instructional Summary
Course Description	Students will; Learn About Basic Principles, Three-phase Circuits, Electrical Environment, Overhead Powerlines, Underground Powerlines and APPA Safety Manual
Student Learning Outcome	Students will; Define and Calculate Electrical Potential, Current, Resistance and Power, Understand and Describe the Characteristics of Three-phase Circuits, Including Delta and Wye Connections, Demonstrate connecting a load in Series and Parallel with a Circuit While Observing Safety Standards for Minimum Approach Distance, Grounding and Bonding, Describe Overhead Powerline Maintenance, Understand APPA Safety Protocols
Instructional Activity	In-Class Lectures Interactive/Demo Labs Online Assignments & Assessments
Material/Equipment	Keys for Lab -Miller Campus Course Access -Canvas LMS
Duration	Course Jan 13 - May 4, 2012 (13 Weeks) Total Hours of Online Student Work (Estimate): _____ Total Hours of Online Instructor Work (Estimate): _____
Notes	Point of Contact: Online- Karma Wayman x5391 Program- Ashley Sokia x5354

(For additional details see the course syllabus.)

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Class Introduction Module

Assignment: Watch video & change your email

PowerPoint: None

Quiz: Practice

1. Which course are you taking?

   Lineman Apprentice 1A, Correct

2. You have read through the course syllabus.

   True

3. Do you have any questions for your new instructor before class begins?

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Basic Electricity Review Module

Assignment: Read WLN #5

PowerPoint: None

Quiz: Basic Electricity

1. Atoms contain electrically charged particles. True or False?

True

2. Insulators offer little opposition to current flow, conductors offer great opposition to current flow. True or False

False

3. A series circuit contains two or more current paths which the components are connected end-to-end. True or False

False

4. In an AC Circuit the magnetic field builds up or collapses continually whenever the current is on. True or False

True

5. The purpose of a transformer is to increase or decrease voltage. True or False

True

6. Removing the voltage source from the capacitor will discharge it. True or False

False

7. Electrons have a [a] charge

a. negative

8. Match the following electrical quantities with the units in which they are measured.

Current = Amperes
Voltage = volts

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Resistance = Ohms

9. A break in the current path of a [a] circuit interrupts the entire circuit.

   a. series

10. Resistors are components that are put into circuits to [a] the current flow.

    a. reduce

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Three-phase Circuits Module

Assignment: Delmar's Unit 27 - Three-phase Circuits

PowerPoint: Unit 27 - Three-phase Circuits

Quiz: Three-phase Circuits

1. To do the power calculations quickly in the field, a ____ Number can be used for approximations.

Handy

2. The voltage across each coil in a delta system is the same as the voltage measured from ____.

phase to phase

3. A(n) ____ system is a circuit fed from a delta-connected secondary of a three-phase transformer bank.

delta

4. A three-phase wye circuit consists of ____ wires.

four

5. ____ markers on underground cable ensure proper connection to overhead conductors.

Phasing

6. The voltage and current in each phase of a three-phase circuit are ____ second behind another phase.

1/180

7. A simplified three-phase generator has three coils mounted on the armature at ____ degrees apart.

120

8. A live conductor in a circuit is called a ____.

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phase

9. For single-phase lines, the Handy Number = ____.

L - N voltage / 1,000

10. Calculations for field applications use the ____ formulas.

kVA

11. ____ power is used in the field because it is what a feeder carries.

Phased

12. Wye connections are represented on paper in the shape of a(n) "____".

Y

13. To complete a circuit, electrical current must return to the ____.

source

14. Electric current needs a ____ before it can flow.

circuit

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Awareness in an Electrical Environment - Part 1 Module

Assignment: Read Chapter 7 Guidebook - Awareness in an Electrical Environment

PowerPoint: None

Quiz: Awareness in an Electrical Environment - Part 1

1. When a person is within an electric field, there is a(n) ____ induced on the body.

voltage

2. The properties that differentiate various sources of rays, including X-rays, ultraviolet light, visible light, infrared light, microwaves, radio waves, heat, and electrical powerline, are the frequency and the ____.

wavelength

3. ____ are energy waves with both an electric component and a magnetic component.

EMFs

4. A person's heart can go into fibrillation after ____ mA of current go through the body for a very short time.

50

5. An object or person near an energized AC circuit is exposed to ____.

Electromagnetic Induction

6. Loads on a distribution feeder are fed through ____.

Transformers

7. Linemen frequently put themselves in a(n) ____ path to ground when working on a wye circuit.

parallel

8. Two or more loads within a circuit are considered to be in ____ when one (common) current is flowing through all the loads.

series

9. The ____ factor minimum approach distance is the space needed to prevent a person from encroaching into the electrical factor distance.

human

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10. An internal source for a transient overvoltage would be a ____ surge.

Switching

11. The minimum approach distance formula is ____.

A + (F x B)

12. ____ radiation is a form of electromagnetic radiation with wavelengths measured in nanometers.

ultraviolet

13. Earth's atmosphere has a naturally occurring electric field that fluctuates on the surface around ____ V/m.

130

14. The word ____ means exposure that produces an effect.

dose

15. To be considered qualified to work closer than ____ feet to a distribution circuit, you must recognize these hazards and know the types of barriers to set in place to control them.

10

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Awareness in an Electrical Environment - Part 2 Module

Assignment: Read Chapter 7 Guidebook - Awareness in an Electrical Environment

PowerPoint: None
Quiz: Awareness in an Electrical Environment - Part 2

1. To be considered qualified to work closer than _____ feet to a distribution circuit, you must recognize these hazards and know the types of barriers to set in place to control them.

10

2. Two or more loads within a circuit are considered to be in _____ when one (common) current is flowing through all the loads.

series

3. Linemen frequently put themselves in a(n) _____ path to ground when working on a wye circuit.

parallel

4. Loads on a distribution feeder are fed through _____.

transformers

5. An object or person near an energized AC circuit is exposed to _____.

electromagnetic induction

6. A person's heart can go into fibrillation after _____ mA of current go through the body for a very short time.

50

7. _____ are energy waves with both an electric component and a magnetic component.

EMFs

8. The properties that differentiate various sources of rays, including X-rays, ultraviolet light, visible light, infrared light, microwaves, radio waves, heat and electrical powerline, are the frequency and the _____.

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wavelength

9. When a person is within an electric field, there is a(n) _____induced one the body.

voltage

10. The word _____ means exposure that produces an effect.

dose

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Awareness in an Electrical Environment - Part 3 Module

Assignment: Read Chapter 14 in Guidebook for Linemen and Cablemen (pgs. 541-562).

Complete review questions on pages 571-578.

PowerPoint: None

Quiz: None

1. Earth's atmosphere has naturally occurring electric field that fluctuates on the surface around _____.

130

2. _____ radiation on is a form of electromagnetic radiation with wavelengths measured in nanometers.

Ultraviolet

3. The minimum approach distance formula is _____.

A + (F X B)

4. An internal source for a transient overvoltage would be a _____ surge

switching

5. The _____ factor minimum approach distance is the space needed to prevent a person from encroaching into the electrical factor distance.

human

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Constructing Overhead Powerlines - Part 1 Module

Assignment: Read chapter 15 in Transformation for Lineworkers (pgs.193-216).

PowerPoint: None

Quiz: Constructing Overhead Powerlines - Part 1

1. ____ projects tend to be very low priorities, because the justification is subjective and it is usually possible to get another year of use out of a line.

Rehabilitation

2. _____ refers to items such as structures, anchors, and conductors.

Plant

3. _____ maintenance focuses on preserving the purpose of the line or equipment.

Reliability-centered

4. _____ maintenance is unscheduled and requires immediate attention.

Corrective

5. Many inspections use _____ technology to reference data to geographic coordinates.

GIS

6. Structure and _____ numbers can be used to accurately identify the location of a structure when preparing a patrol report.

circuit

7. The trend today is to use _____ to determine the latitude and longitude of a structure.

GPS

8. Before a new line is put into service, it goes through a _____ process to ensure that the line was built to specifications.

commissioning

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9. _____ a circuit improves the ground clearance and allows a line to carry more load.

resagging

10. The _____ on a job pays for such things as engineering, accounting, safety professionals, and supervision.

overhead

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Constructing Overhead Powerlines - Part 2 Module

Assignment: Read chapter 15 in Transformation for Lineworkers (pgs.193-216).

PowerPoint: None

Quiz: None

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Constructing Overhead Powerlines - Part 3 Module

Assignment: Read chapter 15 in Transformation for Lineworkers (pgs.193-216).

PowerPoint: None

Quiz: None

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LINEMEN 1210 Midterm Module

Assignment: Complete Midterm Exam

PowerPoint: None

Exam: Midterm

1. The voltage across each coil in a delta system is the same as the voltage measured from ____.

phase to phase

2. A three-phase wye circuit consists of ____ wires.

four

3. ____ markers on underground cable ensure proper connection to overhead conductors.

Phasing

4. A live conductor in a circuit is called a ____.

phase

5. Wye connections are represented on paper in the shape of a(n) "____".

Y

6. To complete a circuit, electrical current must return to the ____.

source

7. When a person is within an electric field, there is a(n) ____ induced on the body.

voltage

8. A person's heart can go into fibrillation after ____ mA of current go through the body for a very short time.

0.05

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9. Linemen frequently put themselves in a(n) ____ path to ground when working on a wye circuit.

series

10. The ____ factor minimum approach distance is the space needed to prevent a person from encroaching into the electrical factor distance.

machine

11. To be considered qualified to work closer than ____ feet to a distribution circuit, you must recognize these hazards and know the types of barriers to set in place to control them.

10

12. ____ maintenance on substation equipment and line equipment such as voltage regulators and reclosers is often based on maintenance schedules either recommended by the manufacturer or “time based.”

Preventative

13. The trend today is to use ____ to determine the latitude and longitude of a structure.

GPS

14. _____a circuit improves the ground clearance and allows a line to carry more load.

Resagging

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Constructing Overhead Powerlines - Part 4 Module

Assignment: None

PowerPoint: None

Quiz: None

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Constructing Overhead Powerlines - Part 5 Module

Assignment: None

PowerPoint: None

Quiz: Constructing Overhead Powerlines Part 2

1. ____ maintenance on substation equipment and line equipment such as voltage regulators and reclosers is often based on maintenance schedules either recommended by the manufacturer or “time based.”

Preventative

2. The trend today is to use ____ to determine the latitude and longitude of a structure.

GPS

3. _____a circuit improves the ground clearance and allows a line to carry more load.

Resagging

4. A ____ design consists mainly of electrical and mechanical engineering considerations.

line

5. ____ projects tend to be very low priorities, because the justification is subjective and it is usually possible to get another year of use out of a line.

Rehabilitation

6. ____ refers to items such as structures, anchors, and conductors.

Plant

7. ____ maintenance focuses on preserving the purpose of the line or equipment.

Reliability-centered

8. ____ maintenance on substation equipment and line equipment such as voltage regulators and reclosers is often based on maintenance schedules either recommended by the manufacturer or “time based.”

Corrective

9. ____ maintenance is unscheduled and requires immediate attention.

Corrective

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10. Many inspections use ____ technology to reference data to geographic coordinates.

GIS

11. Structure and ____ numbers can be used to accurately identify the location of a structure when preparing a patrol report.

circuit

12. The trend today is to use ____ to determine the latitude and longitude of a structure.

GPS

13. Before a new line is put into service, it goes through a ____ process to ensure that the line was built to specifications.

commissioning

14. _____ a circuit improves the ground clearance and allows a line to carry more load.

Resagging

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Constructing Underground Powerlines - Part 1 Module

Assignment: None

PowerPoint: None

Quiz: None

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Constructing Underground Powerlines - Part 2 Module

Assignment: None

PowerPoint: None

Quiz: Constructing Underground Powerlines - Part 2

1. The two main types of underground distribution are

   duct-and-vault and direct-bury

2. What kind of maintenance is carried out on underground systems?

   Underground transmission cables are patrolled, sometimes weekly, to check for potential construction involving digging along the cable route. Less frequently maintenance vaults, cable tunnels, cables attached to bridges, alarm systems, earth resistance, and insulating oil are inspected.

3. Which of these underground utilities should NEVER be encountered when digging a new trench for a power cable.

   Power cable

4. The [a] system is the hardest to install and requires the most civil work.

   duct-and-vault

5. How does a rope used to pull in a cable get installed into the duct?

   Using an air compressor to blow a line carrier (bird) with a small nylon cord attached to it through the duct.

6. Spell out the words for the following acronyms:

   a. High-pressure, fluid-filled
   b. High-pressure, gas filled
   c. Self-contained, fluid-filled
   d. Extruded dielectric, polyethylene

7. How does the backfill for an underground cable affect the current-carrying capacity of the cable?

   Heat dissipation is somewhat dependent on backfill. Backfill designed to move heat away from the cable plays a large part in determining the cable load-carrying capacity.

8. Which of these methods is NOT used to protect direct buried cable.

   unused sewer system pipes

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9. Name three advantages of a vault and duct system for an underground system over a direct bury system.

Cable is protected by concrete ducts with virtually no probability of a dig-in. Sections of cable can be repaired or replaced without civil work. Cable and terminations are accessible at every vault.

10. In a joint-use trench, power cables are laid in the top position.

False

11. Identify the cables in the joint-use trench:

a. Telephone
b. CATV
c. Gee Line
d. Electric Primary

12. A [a] type of connection to a cable allows the highest tension for a pull.

crimp-on pulling eye

13. Before making a pull, where does a person find the maximum allowable tension for a given type of underground cable?

Manufacturer's data will have the maximum allowable tension for the cable.

14. Why do pipe-type transmission line cables have oil-pumping stations?

The oil is kept moving through the pipe to cool the cable and the oil is monitored for contamination.

15. All transformers used on underground systems are installed below the surface of the ground.

False

16. How is a concrete duct in a vault and duct system prepared before a cable is pulled in?

A flexible mandrel is pulled through the length of the conduit.

17. How are cables identified at the terminations?

Each cable must be traced and labeled. Each switching device must be labeled with a corresponding number on an operating drawing.

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APPA Safety Manual Module

Assignment: APPA Safety Manual - Section 507, Review APPA Safety Manual, Review Topics on Live Line Maintenance and Grounding

PowerPoint: None

Quiz: None

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APPA Safety Manual (cont'd) Module

Assignment: Complete quiz

PowerPoint: None

Quiz: APPA Safety Manual

1. Lines of No. 6 copper, No. 6 ACSR, and No. 8A Copperweld or smaller shall not be worked on with live-line tools except when installing or removing a tap.

True

2. When working from an aerial device, it is ok to belt to an adjacent pole or structure.

False

3. If two workers are working on live conductors, one should be responsible for holding the live conductor clear of the other worker.

False

4. Before entering a confined or enclosed space, all levels of the space shall be tested for the lack of oxygen, and then for the presence of flammable or [a] (two words) and [b] (one word). Monitoring instrumentation must be calibrated.

a. toxic gases
b. vapors

5. Portable, metal ladders and other portable conductive ladders may be used in specialized work, such as high voltage substations, as long as they are properly marked.

True

6. According to table 5.2 of the APPA Safety Manual, find the actual minimum distance approach distances for the following:

a. 1'0"
b. 3'2"
c. 3'11"
d. 2'8" - 4'10" depending on overvoltage factors

7. Rubber gloves shall be worn when working on or near series street lightening circuits even though they are disconnected from the source power.

True

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8. What is an employee's responsibility for safety?

Before beginning a job, employees shall satisfy themselves that they can perform the task without injury. If they are in doubt as to their ability to perform the work, they shall call this to the attention of their supervisor.

9. The automatic reclosing feature of circuit interrupting devices are in operation when beginning work.

False

10. Live-line, bare-hand work shall not be performed on voltages less than 69 kV.

True

11. Before using the live-line bare-hand technique on energized high voltage conductors, you must voltage limitations of the aerial lift equipment intended to be used.

True

12. It is a well-known myth that you cannot work on electrical powerlines during an electrical storm, as long as you are well-insulated, you are safe.

False

13. A conductive bucket liner or other suitable conductive device will bond an insulated aerial device to the energized line or equipment.

True

14. The outriggers on the aerial truck are extended and adjusted to stabilize the truck after the boom is elevated.

False

15. The body of a hydraulic truck must be bonded to an effective ground because it is considered energized equipment.

True

16. When proper clearances cannot be maintained during inclement weather, rubber gloves shall be worn when making or breaking a circuit (such as switching and grounding procedures).

True

17. Bare-wire communication conductors or structure are not considered energized lines.

False

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18. Grounding - Equal potential grounding is the preferred method of grounding whenever possible.

True

19. A ground lead can be attached to either a tower ground or a driven ground.

True

20. What is a grounding electrode?

A conductor embedded in the earth, used for maintaining ground potential or conductors connected to it and for dissipating into the earth current conducted to it.

21. When using a grounding electrode, such electrodes shall have a resistance to ground low enough to permit prompt operation of protective devices.

True

22. When attaching a ground to a line or to equipment, the ground-end connection shall be attached first, and then the other end shall be attached by using a live-line tool.

True

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LINEMEN 1210 Final Module

Assignment: Complete Final Exam

PowerPoint: None

Exam: Final

1. ____ maintenance on substation equipment and line equipment such as voltage regulators and reclosers is often based on maintenance schedules either recommended by the manufacturer or “time based.”

Preventative

2. The trend today is to use ____ to determine the latitude and longitude of a structure.

GPS

3. ___ refers to items such as structures, anchors, and conductors.

Plant

4. Many inspections use ____ technology to reference data to geographic coordinates.

GIS

5. Structure and ____ numbers can be used to accurately identify the location of a structure when preparing a patrol report.

circuit

6. The trend today is to use ____ to determine the latitude and longitude of a structure.

GPS

7. Before a new line is put into service, it goes through a ____ process to ensure that the line was built to specifications.

commissioning

8. The two main types of underground distribution are _____.

duct-and-vault and direct-bury

9. What kind of maintenance is carried out on underground systems?

Underground transmission cables are patrolled, sometimes weekly, to check for potential construction involving digging along the cable route. Less frequently maintenance vaults,

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cable tunnels, cables attached to bridges, alarm systems, earth resistance, and insulating oil are inspected.

10. Which of these underground utilities should NEVER be encountered when digging a new trench for a power cable.

Power cable

11. Identify the cables in the joint-use trench:

a. Telephone
b. CATV
c. Gee Line
d. Electric Primary

12. A [a] type of connection to a cable allows the highest tension for a pull.

a. crimp-on pulling eye

13. Before making a pull, where does a person find the maximum allowable tension for a given type of underground cable?

Manufacturer's data will have the maximum allowable tension for the cable.

14. All transformers used on underground systems are installed below the surface of the ground.

False

15. What is the definition of "minimum approach distance."

The closets distance an employee is permitted to approach an energized or grounded object.

16. What is secondary voltage?

Any electrical circuit that normally operates at less than 600 volts.

17. Portable metal ladders and other portable conductive ladders may be used in specialized work such as, high voltage substations, as long as they are properly marked.

True

18. The automatic reclosing feature of circuit interrupting devices are in operation when beginning work.

False

19. Live-line bare-hand work shall not be performed on voltages less than 69 kV.

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True

20. Aerial lifts to be used for live-line, bare-hand work shall have dual controls (lower and upper).

True

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LINEMEN - 1220 2B

	Instructional Summary
Course Description	Students will; Learn Delta and Wye Systems, Three-phase Transformer Connections, Transformers, Three-phase Transformer Connections, Transformers, Three-phase, Transformer Connections, Vector Principles, Three-phase Learning Objectives, Aerial Devices and Digger Derricks, Rigging and Knot Tying.
Student Learning Outcome	Students will; Describe the Characteristics of Delta and Wye Connected Systems, Three-phase Configurations, Understand Transformations Effect on Current, Voltage Conversions and Transformer Troubleshooting, Describe Types of Three-phase Transformer Connections, Describe European, Urban & Network Grid Systems, Safely Operate Vehicles, Booms and Aerial Equipment Regularly Used in Line Work. Perform Hardware Rigging.
Instructional Activity	In-Class Lectures Interactive/Demo Labs Online Assignments & Assessments
Material/Equipment	Keys for Lab Access -Miller Campus Course Access -Canvas
Duration	Course Jan 13 - May 4, 2012 (13 Weeks) Total Hours of Online Student Work (Estimate): _____ Total Hours of Online Instructor Work (Estimate): _____
Notes	Point of Contact: Online- Karma Wayman x5391 Program- Ashley Sokia x5354

(For additional details see the course syllabus.)

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Class Introduction Module

Assignment: Watch video & change your email

PowerPoint: None

Quiz: Practice

1. Which course are you taking?

   Lineman 2B

2. How do you change your e-mail and notification settings?

   The profile link in the top right hand corner.

3. You have downloaded your class syllabus

   True

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Characteristics of Delta and Wye Systems Module

Assignment: Read Chapter 13 - Transformation for Lineworkers

PowerPoint: None

Quiz: Characteristics of Delta and Wye Systems

1. To supply a three-phase service from a delta supply line, what is the required minimum number of phase conductors?

Three

2. To supply a three-phase service from a delta supply line, what is the required minimum number of transformers?

Two

3. When two transformers are used to supply a delta 3-phase service, what is the output capacity of equally sized transformers?

86.6 or 87 percent

4. One transformer failed in a bank of 3-100 kVA transformers that supplied a delta 3-phase service. It was isolated and the 2 remaining transformers were re-energized to provide open-delta – open delta service. Compared to the original bank, what is the available percentage or kVA capacity?

57.6 or 58 percent

5. What happens in a delta circuit if one phase becomes grounded?

The circuit will continue to operate but the voltage between each of the other two phases and ground increases to the maximum voltage between phases. This creates voltage stress on the insulators and transformer bushings. Also, a ground on a second phase will cause a short circuit condition. (pg. 153)

6. In a delta configuration, how does current in the lines compare to current in the windings?

The line current is equal to 1.73 times the winding current or winding current divided by

1.73 equals the line current. (pg. 153)

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7. What happens to the voltage across the windings of a delta transformer bank when a delta supply phase is opened? How does this affect service?

On a delta system when loss of one supply phase occurs, the remaining two phases can only supply single-phase power. Low voltage will result across the transformers connected to the open phase. Two of the transformers will be connected in series across the remaining two supply phases and would have only a single-phase supply. (pg. 153)

8. What type of three-phase system uses a common neutral conductor?

Wye (star) connected systems

9. In a wye system, how does the current in each phase compare to its winding?

The current in the windings is equal to the current in the phase attached to it. (pg. 155)

10. Why is a wye (star) system generally safer than a delta system?

The wye system is generally safer because if a phase breaks, it is shorted to ground. The short circuit that results usually causes the fuse or circuit breaker to open and disconnect the defective phase or conductor. (pg. 155)

11. What makes transformers specifically designed for wye configurations cheaper than transformers that can be used for any three-phase service?

The bushing on the grounded side of a star winding can be a low-voltage bushings or a tank mounted uninsulated terminal. These attachments are less expensive than fully insulated bushings. (pg. 155)

12. How does the load balance in a 4-wire wye (star) system affect the current in its neutral?

In the phase conductors of a three-phase wye circuit; if the currents are balanced there is no current in the neutral and, if the phase currents are unbalanced then a current flows in the neutral. This neutral current is the vectoral sum of the current differences. If there is no neutral conductor available, it flows through the earth. (pg. 156)

13. On a wye system, the [a] _____ voltage is divided by 1.73 to determine the [b] _____ voltage or the [c] _____ voltage.

a. line-to-line
b. winding
c. line-to-neutral

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14. In a delta system, the [a] _____ voltage is [b] _____ to the line-to-line voltage.

a. winding
b. equal

15. In a wye system, the [a] _____ current is [b] _____ to the line current.

a. winding
b. equal

16. In a delta system, the [a] _____ current is [b] _____ to determine the line current.

a. winding
b. multiplied by 1.73

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Three-phase Transformer Connections - Part 2 Module

Assignment: Read Speakman's Rules

PowerPoint: None

Quiz: Three-Phase Transformer Connections 1

1. How do open-Y and open-delta configurations differ from closed-Y and closed-delta?Draw the symbols for all four winding configurations.

Both closed-y and closed-delta use three transformers whereas open-y and open-delta only use two transformers. (pg. 163)

2. Describe three-phase service and the most common primary and secondary configurations.

The term, “three-phase” is applied to any current-consuming or current-carrying apparatus designed to be activated or energized by three distinct voltages or phases. A delta 3-phase system consists of three phase conductors and a wye (star) system consists of three phase conductors and a neutral. The neutral point may be a conductor or it may be a ground (earth return). Primary lines are usually three-phase 4-wire wye and secondary lines are usually three-phase three wire systems but the proportion of 4-wire wye systems is increasing. (pg. 162)

3. What is the basic “rule” for connecting 3 transformers in a wye configuration?

Connect 3 “like” terminals to a common point (wye point). The remaining 3 “like” terminals receive or supply individual phases. (pg. 163)

4. What is the basic “rule” for connecting 3 transformers in a delta configuration?

Connect 2 “unlike” terminals of two different transformers together to form each phase terminal point (3 terminal points). The 3 terminal points receive or supply individual phases. (pg. 162) Caution: Do not connect 2 “unlike” terminals of one transformer together as this would cause a short circuit.

5. In a delta transformer bank the voltage across each winding is equal to_____ voltage.

Phase to phase.

6. In a delta transformer bank the [a] current is divided by 1.73 to determine the [b] current. Winding current is [c] percent of line current.

a. Line
b. winding

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c. 58%

7. Depending on the wiring configurations of delta-delta transformer banks, the phase angle displacements between the primary and secondary could be [a] degrees or [b] degrees.

a. 0 degrees
b. 180 degrees

8. Single phase 120/240 volt service is required from a three-phase 240 volt delta bank. Can this be done? If so, describe how you would proceed.

Yes
Connect an X2 of one transformer to the secondary neutral and connect the 120/240 volt single-phase service to the neutral and hot legs of the same transformer. (pg. 169)

9. What precaution is necessary when connecting a single-phase 120/240 volt service to a4-wire 240 volt delta secondary?

Avoid connecting a 120 volt load to the one 208 volt line-to-neutral position. (pg. 169)

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The Purpose of a Transformers - Part 1 Module

Assignment: Read pages 541-562 in Transformation for Lineworkers. Read chapter 14 in Guidebook for Linemen and Cablemen. Read Chapter 14 - Guidebook

PowerPoint: None

Quiz: The Purpose of a Transformer

1. Whether the transformer is additive or subtractive is based on the ____ of the coil winding.

direction

2. The terminals of a transformer have a fixed ____ in relation to other terminals.

polarity

3. Distribution transformers with taps typically have tap settings that raise or lower the voltage ____% for each tap.

2.5

4. The transformer ratio is calculated using the equation ____.

input/output = transformer ratio

5. A ____ test will ensure that there are no shorts between turns in the windings.

ratio

6. Regardless of the turns ratio, and ignoring some transformer losses, the energy input into the transformer is ____.

equal to the energy output

7. A ____ is an electromagnetic device that provides a magnetic linkage between two electrical circuits.

transformer

8. When a single-wire earth return (SWER) system is feeding a transformer, then the pole/down ground is the primary ____.

neutral

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9. Ferro resonance can cause the voltage on a circuit to increase from two to ____ times, causing equipment damage.

nine

10. When the primary of the transformer is opened, the primary terminal will remain energized because of ____ from the energized secondary.

backfeed

11. ____ are high-capacity fuses designed and fused to blow before the cable insulation is damaged by heat from excessive current feeding a fault.

Limiters

12. Network transformers are ____-phase units.

three

13. In the American system, one three-phase transformer is used to feed about ____ times the length of a typical single-phase secondary bus for a given load and for the same voltage drop limitation.

eight

14. The ____ transformer is used to reduce the voltage on local distribution lines to a utilization voltage.

step-down

15. Most people worldwide use the ____ distribution system to feed utilization voltages to the customers.

European

16. A ____ is a tapped autotransformer that can regulate voltage under loaded conditions.

voltage regulator

17. ____ transformers are potential transformers and current transformers that reduce voltage and current to lower, manageable levels.

grounding

18. A ____ transformer is used as an indirect way to ground one phase of a delta circuit.

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distribution

19. A ____ transformer is one that is used where telecommunications (telephone) cable enters a substation.

neutralizing

20. A three-phase service supplied to a customer should not have a voltage imbalance exceeding ____%.

1

21. When two or more transformers are connected in a(n) ____ configuration, the coils are connected in series with each other.

delta

22. a ground wire is a

grounding conductor

23. The ____ ratio of a transformer determines the ratio between the primary voltage and the secondary voltage.

holes

24. When single-phase transformers are to be connected in parallel or connected into a three-phase bank, it is normal to select transformers with the same ____.

polarity

25. The power carried in a circuit is equal to ____.

volts x amperes

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Three-phase Transformer Connections - Part 3 Module

Assignment: Read and review chapter 15 in Transformation for Lineworkers.

PowerPoint: None

Quiz: 3-Phase Transformer Connections 2

1. What does it mean if a transformer bank is described as Δ-Y or Y-Δ ?

   The symbols Δ-Y represent a bank of three transformers whose primary windings are in a delta connection and secondary windings are in a wye or star connection.
   The symbols Y-Δ represent a bank of three transformers whose primary windings are in a wye or star connection and secondary windings are in a delta connection. (pgs. 171, 173)

2. Primary and secondary neutrals on wye-wye banks must always be grounded to maintain voltage stability. True or False

   True

3. In wye-wye transformer banks it is possible to have phase angle displacements between the primary and secondary of [a] _____ degrees or [b] _____ degrees depending on wiring configurations.

   0

4. Wye-delta banks may be connected for either a [a] _____ degree or [b] _____ degree phase angle displacement between the primary and the secondary.

   30

5. On a 3-transformer wye-delta bank the wye point is normally grounded. True or False

   False

6. If one transformer fails in a 3-transformer delta-delta bank and emergency service is provided with the two remaining transformers (open delta – open delta), the capacity is [a] _____ percent of the original 3-transformer bank or [b] _____ percent of the remaining two transformers.

   a. 57.7%

   b. 86.6%

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Three-phase Transformer Connections - Part 4 Module

Assignment: Read Chapter 15 in Transformation for Lineworkers, Midterm Review, Review Chapter 14 in Guidebook for Linemen and Cablemen.

Complete questions on pages 571-579 in Guidebook for Linemen and Cablemen.

PowerPoint: None

Quiz: 3-Phase Transformer Connections 3

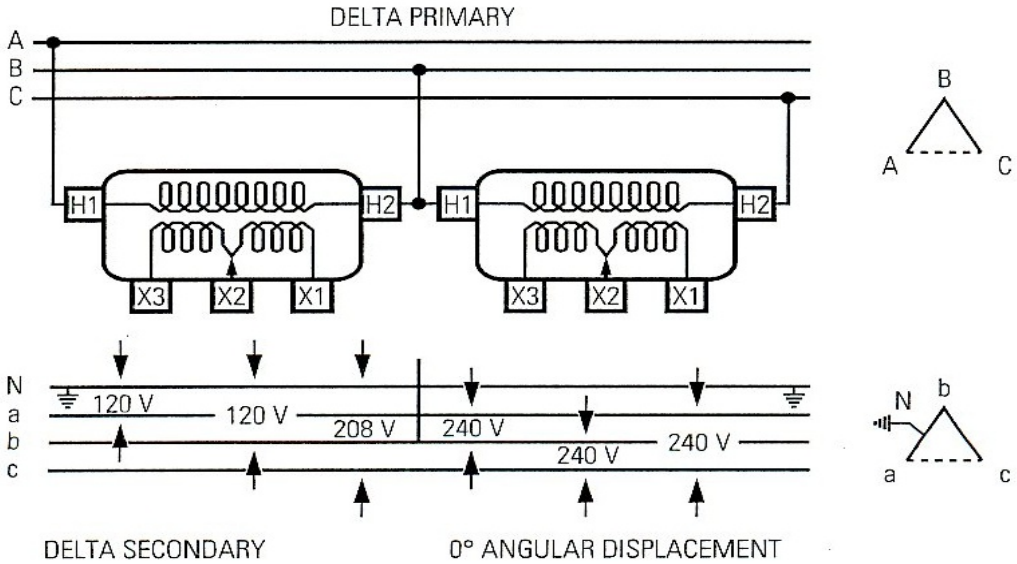
1. One transformer has failed in a 3-transformer wye-delta bank. It is necessary to reconnect the remaining two transformers into an open wye – open delta configuration for emergency service. Why is it necessary to ground the primary neutral (Y-point) in an open wye – open delta three-phase installation?

To prevent the two remaining transformers from forming a series connection between the two primary phases because this would cause a single-phase condition at a reduced voltage.

2. Describe how you would convert the bank from a wye-delta to an open wye-open delta.

Isolate the failed transformer, ground the primary neutral (wye) point and re-energize the bank at reduced capacity. Pg 175

3. A 3-phase bank supplies 120/240 volt single-phase and 240 volt 3-phase service. Complete the connections below to rewrite the Δ-Δ bank as an open-Δ bank after a failure of the first transformer. Include all phases and secondary voltages.



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4. Why is it necessary to ground the primary neutral (Y-point) in an open wye-open delta three-phase installation?

To prevent the two remaining transformers from forming a series connection between the two primary phases because this would cause a single-phase condition at a reduced voltage.

5. One transformer fails in a 3-transformer wye-delta bank. After restoring service with the two remaining transformers, the output capacity is [a] percent of the two transformers or [b] percent of the original three equally sized transformers.

a. 86.6
b. 57.7

6. One transformer fails in a 3-transformer wye-delta bank. After restoring service with the two remaining transformers, the output capacity is [a] percent of the two transformers or [b] percent of the original three equally sized transformers.

a. 75
b. 50

7. The output or secondary type of connections used, closed or open wye or delta, dictate the applicable percentages of capacity available. True or False

True

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Linemen 1220 Midterm Module

Assignment: Complete Midterm

PowerPoint: None

Exam: Midterm

1. What happens in a delta circuit if one phase becomes grounded?

The circuit will continue to operate but the voltage between each of the other two phases and ground increases to the maximum voltage between phases. This creates voltage stress on the insulators and transformer bushings. Also, a ground on a second phase will cause a short circuit condition. (pg. 153)

2. Why is a wye (star) system generally safer than a delta system?

The wye system is generally safer because if a phase breaks, it is shorted to ground. The short circuit that results usually causes the fuse or circuit breaker to open and disconnect the defective phase or conductor. (pg. 155)

3. How does the load balance in a 4-wire wye (star) system affect the current in its neutral?

In the phase conductors of a three-phase wye circuit; if the currents are balanced there is no current in the neutral and, if the phase currents are unbalanced then a current flows in the neutral. This neutral current is the vectoral sum of the current differences. If there is no neutral conductor available, it flows through the earth. (pg. 156)

4. In a delta transformer bank the voltage across each winding is equal to_____ voltage.

phase-to-phase

5. Single phase 120/240 volt service is required from a three-phase 240 volt delta bank.Can this be done? If so, describe how you would proceed.

Yes. Connect an X2 of one transformer to the secondary neutral and connect the 120/240 volt single-phase service to the neutral and hot legs of the same transformer. (pg. 169)

6. Whether the transformer is additive or subtractive is based on the _____ of the coil winding

direction

7. Distribution transformers with taps typically have tap settings that raise or lower the voltage _____% for each tap.

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2.5

8. The transformer ratio is calculated using the equation _____.

input/output = transformer ratio

9. Primary and secondary neutrals on wye-wye banks must always be grounded to maintain voltage stability.

True

10. If one transformer fails in a 3-transformer delta-delta bank and emergency service is provided with the two remaining transformers (open delta – open delta), the capacity is [a] _____ percent of the original 3-transformer bank or [b] _____ percent of the remaining two transformers.

57.7%

11. One transformer has failed in a 3-transformer wye-delta bank. It is necessary to reconnect the remaining two transformers into an open wye – open delta configuration for emergency service. Why is it necessary to ground the primary neutral (Y-point) in an open wye – open delta three-phase installation?

To prevent the two remaining transformers from forming a series connection between the two primary phases because this would cause a single-phase condition at a reduced voltage.

12. Describe a three-phase transformer.

Three-phase transformers have the high and low-voltage windings of all three-phases mounted inside one tank and the magnetic circuits of the three-phases are interlinked in the same core. (pg. 168)

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Apply Vector Principles Module

Assignment: None

PowerPoint: None

Quiz: Apply Vector Principles

1. What four characteristics are necessary to describe the output voltages of a transformer bank?

a. Magnitude
b. Direction
c. Phase angle
d. Phase sequence pg. 194

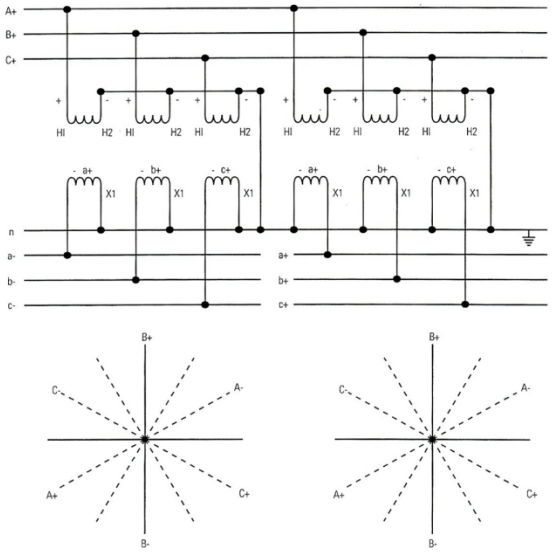
2. On a vector wheel, how many degrees of separation are between each division of the wheel and between each phase of a three-phase system?

There are 30 degrees between each division and 120 degrees between each phase of a three-phase system. Pg 195

3. On a star-star three-phase bank, the phase angle displacement between the primary and secondary windings is either [a] degrees or [b] degrees.

a. 0
b. 180 Pg 197

4. Plot the following star-star transformer banks on the vector wheels provided. Label the primary and the secondary vectors that you have plotted.



5. The primary to secondary phase angle displacement of bank #1 is [a] _____ degrees and on bank #2 (right) the phase angle displacement is [b] _____ degrees.

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a. 180
b. 0 Pg. 201

6. Is it possible to parallel these two transformer banks?

No
The secondary systems of the two banks are opposite each other, i.e. 180 electrical degrees apart. The voltages between A1 and A2, B1 and B2, C1 and C2 would be double the line-to-neutral voltages.

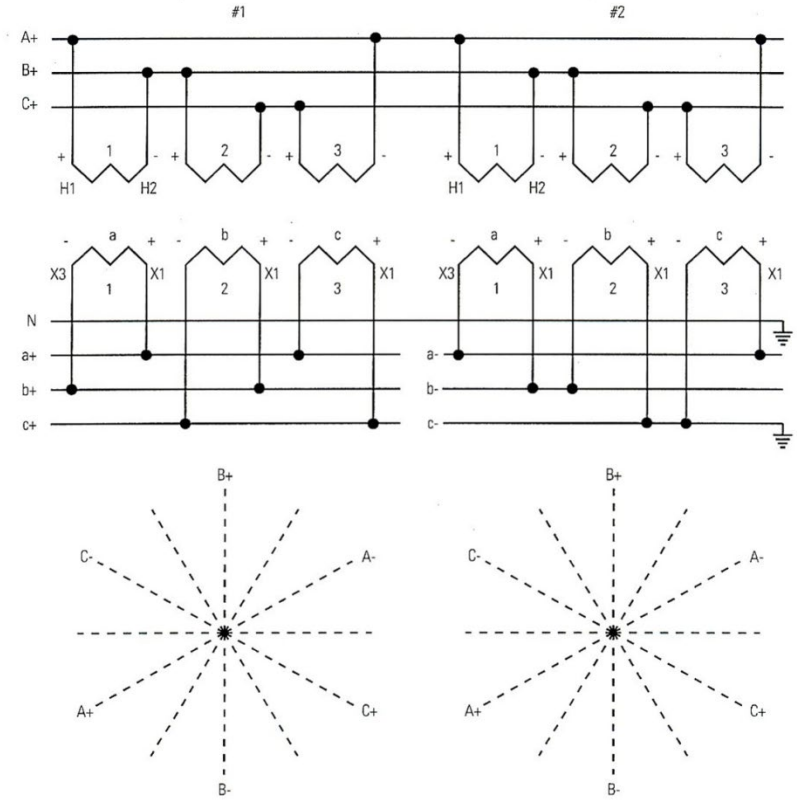
7. When plotting a delta system, the three phase terminals of the triangle align with the diagram axis (A+, B+, C+).

False
Pg. 204

8. Delta phase terminals are displaced [a] degrees from the vector wheel axis.

30

9. Complete the vector wheel diagrams for each delta-delta bank below. Label the primary and secondary vectors that you have plotted.



10. The primary to secondary phase angle displacement of bank #1 is [a] degrees and of bank #2 is [b] degrees.

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a. 0
b. 180
Pg. 209

11. Is it possible to parallel the secondary of these transformer banks?

No
The secondary circuits are opposite to each other, i.e. 180 degrees apart. Double the line voltages would be encountered. (pg. 209)

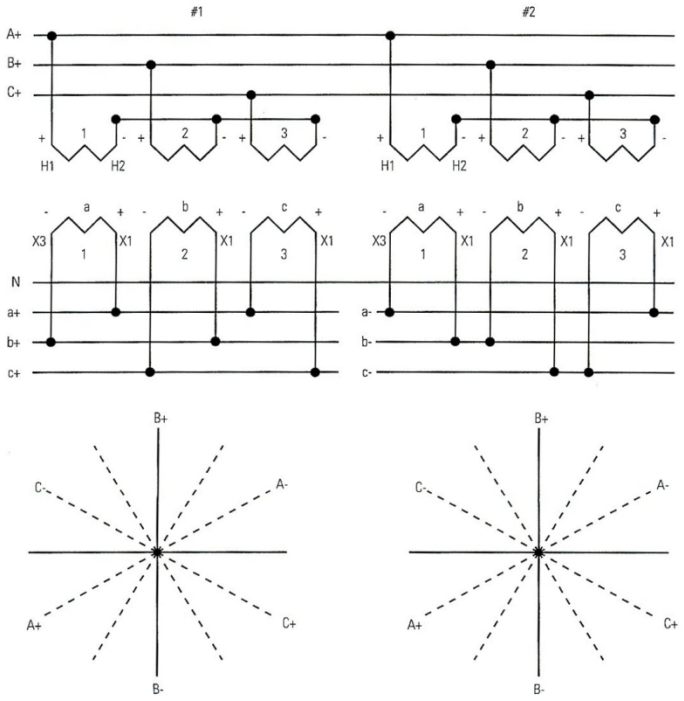
12. When plotting wye-delta transformer banks on the vector wheel what are the possible primary to secondary phase angle displacements?

30 degree and 210 degrees

13. Is it possible to have a 0 degree phase angle displacement between the primary and secondary of wye-delta banks or delta-wye banks?

No
Delta terminals are always 30 degrees off phase axis and wye terminals are always on phase axis on the vector wheel. (pg. 211 and 212)

14. Plot the following wye-delta transformer banks on the vector wheels provided. Labelthe primary and secondary vectors that you have plotted.



15. The primary to secondary phase angle displacement of bank #1 (left) is [a] degrees and on bank #2 (right) is [b] degrees.

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a. 30
b. 210

16. Is it possible to parallel the secondary of these two transformer banks?

Yes
The secondary circuits are opposite to each other, i.e. 180 degrees apart.

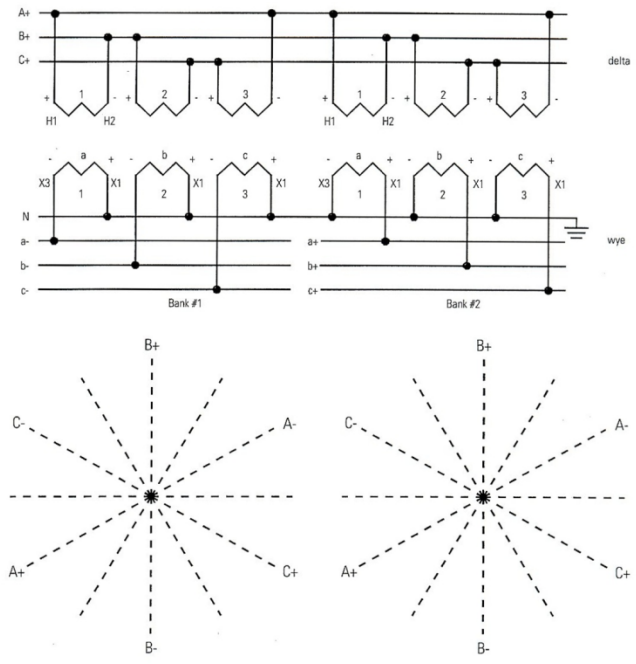
17. In Δ-Y transformer banks, what are the possible angles of displacement between theprimary and secondary circuits?

-30 degrees and -210 degrees

18. Is it possible to have a 0 degree phase angle displacement between the primary and secondary circuits and delta-wye banks?

No
0 degrees phase angle displacement between delta and wye is not possible

19. Plot the following delta-wye transformer banks on the vector wheels provided. Label the primary and secondary vectors that you have plotted.



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Purpose of Transformers - Part 2 Module

Assignment: Read chapter 14 in the Guidebook for Linemen and Cablemen, paying close attention to "Troubleshooting Transformers" on pages 562-565 and "Hazards in Transformers" pages 575-579.

PowerPoint: None

Quiz: Purpose of a Transformer 2

1. Whether the transformer is additive or subtractive is based on the ____ of the coil winding.

   direction

2. The terminals of a transformer have a fixed ____ in relation to other terminals.

   polarity

3. Distribution transformers with taps typically have tap settings that raise or lower the voltage ____% for each tap.

   2.5

4. A ____ test will ensure that there are no shorts between turns in the windings.

   ratio

5. Regardless of the turns ratio, and ignoring some transformer losses, the energy input into the transformer is ____.

   equal to the energy output

6. When a single-wire earth return (SWER) system is feeding a transformer, then the pole/down ground is the primary ____.

   neutral

7. When the primary of the transformer is opened, the primary terminal will remain energized because of ____ from the energized secondary.

   hiss

8. The ____ transformer is used to reduce the voltage on local distribution lines to a utilization voltage.

   step-down

9. Most people worldwide use the ____ distribution system to feed utilization voltages to the customers.

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European

10. ____ transformers are potential transformers and current transformers that reduce voltage and current to lower, manageable levels.

grounding

11. A ____ transformer is used as an indirect way to ground one phase of a delta circuit.

distribution

12. A ____ transformer is one that is used where telecommunications (telephone) cable enters a substation.

neutralizing

13. When two or more transformers are connected in a(n) ____ configuration, the coils are connected in series with each other.

wye

14. A ground wire is a ____.

grounding strap

15. The ____ ratio of a transformer determines the ratio between the primary voltage and the secondary voltage.

holes

16. Describe how you would convert the bank from a wye-delta to an open wye-open delta.

Isolate the failed transformer, ground the primary neutral (wye) point and re-energize the bank at reduced capacity. Pg 175

17. One transformer fails in a 3-transformer delta-wye bank. After restoring service with the two remaining transformers, the output capacity is [a] percent of the two transformers or [b] percent of the original three equally sized transformers.

a. 75
Pg. 182

18. A ____ is a tapped autotransformer that can regulate voltage under loaded conditions.

voltage regulator

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Three-Phase Transformer Connections - Part 5 Module

Assignment: Review chapter 15 in Transformation for Lineworkers.

PowerPoint: None

Quiz: 3-Phase Transformer Connections 4

1. Describe a three-phase transformer.

Three-phase transformers have the high and low-voltage windings of all three-phases mounted inside one tank and the magnetic circuits of the three-phases are interlinked in the same core. (pg. 168) 47

2. Describe an autotransformer, using the names of its windings.

Instead of the two separate windings seen in a typical distribution transformer, the autotransformer has its windings connected in series forming one winding with two parts. The part between the load connections is called the common winding and the part of the winding outside the load connections is called the series winding. (pgs. 169 and 170)

4. List some advantages and disadvantages of an autotransformer.

The primary advantage an autotransformer possesses is that only a portion of the power is transferred by electromagnetic induction while the rest flows directly from the primary lines to the secondary lines without transformation. Other advantages of the autotransformer are smaller size, lower cost, greater efficiency, smaller exciting current, and better voltage regulation. The disadvantages of the autotransformer are larger short-circuit currents and the existence of a connection between a low-voltage and high-voltage circuits. (pgs. 169 and 170)

5. How do open-Y and open-delta configurations differ from closed-Y and closed-delta?Draw the symbols for all four winding configurations.

Both closed-y and closed-delta use three transformers whereas open-y and open-delta only use two transformers. (pg. 163)

6. What is the basic “rule” for connecting 3 transformers in a delta configuration?

Connect 2 “unlike” terminals of two different transformers together to form each phase terminal point (3 terminal points). The 3 terminal points receive or supply individual phases. (pg. 162) Caution: Do not connect 2 “unlike” terminals of one transformer together as this would cause a short circuit.

7. In a delta transformer bank the voltage across each winding is equal to_____ voltage.

phase to phase. (pg. 168)

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8. In a delta transformer bank the [a] current is divided by 1.73 to determine the [b] current. Winding current is[c] percent of line current.

Line
Pg. 168

9. Depending on the wiring configurations of delta-delta transformer banks, the phaseangle displacements between the primary and secondary could be [a] degrees or [b] degrees.

a. 0 degrees
b. 180 degrees

10. Single phase 120/240 volt service is required from a three-phase 240 volt delta bank.Can this be done? If so, describe how you would proceed.

a. Yes
Connect an X2 of one transformer to the secondary neutral and connect the 120/240 volt single-phase service to the neutral and hot legs of the same transformer. (pg. 169)

11. What precaution is necessary when connecting a single-phase 120/240 volt service to a4-wire 240 volt delta secondary?

Avoid connecting a 120 volt load to the one 208 volt line-to-neutral position. (pg. 169)

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Three-Phase Transformer Connections - Part 6 Module

Assignment: Review chapter 15 in Transformation for Lineworkers.

PowerPoint: None

Quiz: 3-Phase Transformer Connections 4

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Aerial Devices and Digger Derricks Module

Assignment: Read chapter 16 in Guidebook for Lineman and Cableman. Complete review questions on page 661.

PowerPoint: None

Quiz: Aerial Devices and Digger Derricks

1. Boom-type equipment is designed to work at a slope of ____ degrees or less.

   5

2. ____ prevent outriggers from penetrating the ground surface.

   Pads

3. A ____ indicates back pressure at the pump.

   high-pitched whine

4. Only ____ hydraulic fluids are used in insulated aerial devices.

   non-insulated

5. For a truck without antilock brakes, use ____ braking in an emergency stop.

   stab

6. ____ are often installed on large trucks to facilitate jump-starting

   studs

7. A maintenance-free battery should not be jump-started if the indicator is ____.

   red

8. If the slack adjusters are over ____ degrees, they will not meet regulatory compliance.

   90

9. The winch and hydraulic jib used on material-handling units are for ____ loads only.

   vertical

10. The loading of a jib is also dependent on the ____ and length of extension.

    angle

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11. To remove a pole out of the ground, use the ____.

hydraulic pole jack

12. If the winch creeps down under load, the ____ needs maintenance.

winch brake

13. The derrick operation hand signal that has the upper arm extended to the side, forearm and index finger pointing straight up, and hand and finger making small circles indicates ____.

hoist up

14. The derrick operation hand signal that has both arms extended horizontally to the side, palms down, and arms swinging back and forth indicates ____.

emergency stop

15. Under the law, the ____ is totally responsible for a utility truck including if it has poor brakes, is overloaded, or has defective tires.

driver

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Rigging in Powerline Work (Knots) Module

Assignment: None

PowerPoint: Rigging

Quiz: Rigging in Powerline Work

1. ____ are preferred for distribution work such as lifting transformers and regulators because they are more resistant to cutting and abrasion than fiber rope and are easier to work with than wire rope or chains.

Web slings

2. A ____ has become the hoist of choice, as well as the hoist that is most abused.

web hoist

3. Chain hoists are constructed with the ____ being the weakest part.

lower hook

4. One adage to ease remembering when installing the U bolts is: "____."

never saddle a dead horse

5. The ____ splice is probably the only splice still seen in line work.

eye

6. A(n) ____ hitch is a friction hitch used to tie on to another rope to prevent it from moving or running.

taut-line

7. A ____ is a knot that can be used to make a lasso or noose, but because it stays in position, it is also useful for jobs such as tying a rope to a pole when rope guying.

running bowline

8. ____ load limit identifies the capacity of individual rigging components.

Working

9. ____ sag refers to the sag under ice loading, wind, and temperature.

maximum

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10. A ____ represents the behavior of all the spans in the line section, and using it determines which sag data to use.

ruling span

11. A line ____ must be known to confirm the proper framing for the structure, and be capable of calculating the bisect tension involved in handling a conductor.

angle

12. The tension on a down guy is calculated using the formula ____.

line tension (T) x length of the guy (L) / Distance to the anchor (D)

13. A ____ hitch is the weakest form of a hitch.

single-wrap choker

14. A ____ is a hoisting device that is also used by many utilities as a pole-top/tower-top rescue device.

hand line

15. One of the more important skills when doing transmission line work is the use of proper ____.

rigging

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Linemen 1220 Final Module

Assignment: Complete Final

PowerPoint: Rigging

Exam: Final

1. What four characteristics are necessary to describe the output voltages of a transformer bank?

a. Magnitude
b. Direction
c. Phase angle
d. Phase sequence

2. Delta phase terminals are displaced [a] degrees from the vector wheel axis.

30

3. When the primary of the transformer is opened, the primary terminal will remain energized because of _____ from the energized secondary.

backfeed

4. A ground wire is a _____.

grounding conductor

5. The _____ratio of a transformer determines the ratio between the primary voltage and the secondary voltage.

turns

6. In a delta transformer bank the [a] current is divided by 1.73 to determine the winding current. Winding current is [b] percent of line current.

a. line
b. 58

7. In a delta transformer bank the voltage across each winding is equal neutral [a] voltage.

phase-to-phase

8. On a three-transformer wye-delta bank, the wye point is normally grounded.

False

9. Boom-type equipment is designed to work at a slope of _____degrees or less.

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2

10. The loading of a jib is also dependent on the _____ and length of extension.

angle

11. To remove a pole out of the ground, use the _____.

hydraulic pole jack

12. _____are preferred for distribution work such as lifting transformers and regulators because they are more resistant to cutting and abrasion than fiber rope and are easier to work with than wire rope or chains.

Web slings

13. The _____ splice is probably the only splice still seen in line work.

eye

14. A _____ is a knot that can be used to make a lasso or noose, but because it stays in position it is also useful for jobs such as tying a rope to a pole when rope guying.

running bowline

15. A _____ represent the behavior of all the spans in the line section, and using it determine which span data to use.

ruling span

16. A _____ is a hoisting device that is also used by many utilities as a pole-top/tower top rescue device.

hand line

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LINEMEN - 2310 3A

	Instructional Summary
Course Description	Insert here
Student Learning Outcome	Insert here
Instructional Activity	In-Class Lectures Interactive/Demo Labs Online Assignments & Assessments
Material/Equipment	Keys for Lab Access -Miller Campus Course Access -Canvas
Duration	Course Jan 13 - May 4, 2012 (13 Weeks) Total Hours of Online Student Work (Estimate): _____ Total Hours of Online Instructor Work (Estimate): _____
Notes	Point of Contact: Online- Karma Wayman x5391 Program- Ashley Sokia x5354

(For additional details see the course syllabus.)

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Class Introduction Module

Assignment: Watch video & change your email

PowerPoint: None

Quiz: Practice

1. Which course are you taking?

   Lineman 3A

2. True or False: You have downloaded your class syllabus.

   True

3. How do you change your e-mail and notification settings for your online class?

   Profile link in the top right hand corner

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Working with Conductors and Cables - Part 1 Module

Assignment: Read Chapter 10 in Guidebook for Lineman and Cablemen, pages 323-351.

PowerPoint: None

Quiz: None

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Working with Conductors and Cables - Part 2 Module

Assignment: Read Chapter 10 in Guidebook for Lineman and Cableman, pages 351-381.

PowerPoint: None

Quiz: Working with Conductors and Cables

1. ____ cable is like underground cable with an added protective shield around it.

Submarine

2. Oil-filled cables are referred to as ____ cable.

HPFF

3. ____ bonds two materials into an electrical connection by melting them together.

Exothermic welding

4. Splices, terminations, and connections, especially for large conductors, are compressed onto a conductor with hydraulic presses and ____.

dies

5. Overhead secondary bus and service drops under ____ V can be aluminum or copper, many sizes, open wire, aerial cable, and neutral-supported aerial cables.

600

6. A ____ conductor is an arrangement of conductors in which each phase has two or more conductors in parallel.

bundled

7. ____ is the current in amperes that a conductor can carry continuously without exceeding its temperature rating.

Ampacity

8. A ____ splice uses an electric arc to fuse the fibers together.

fusion

9. When working with fiber optic cable, a ____ is necessary because any pulling tension will cause twisting forces on the cable.

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swivel pulling eye

10. All-dielectric self-supporting (ADSS) fiber optic cable is typically strung ____ feet below existing conductors.

10 to 30

11. The inside of a fiber cable is coated with a _____.

mirror

12. Fiber optics use ____ to transmit information down glass fibers.

light pulses

13. A fault on a secondary underground cable often starts out as a complaint of ____.

erratic power

14. From an electrical perspective, the selection of a conductor is based on the ____ and voltage requirements of the circuit.

ampacity

15. A break in the insulation of a secondary cable is often a ____ fault.

high-resistance

16. A ____ finds the short circuit by storing a high-voltage charge in its capacitor and then discharging it into the cable to cause a flashover and an acoustic shock wave at the fault location.

thumper

17. A(n) ____ megohmmeter reading indicates a series fault where the conductor and/or neutral are burned open, or it indicates a cable without a fault.

infinity

18. A(n) ____ can be used to test the insulation resistance of the cable and to verify if there is a fault that cannot be pinpointed.

megohmmeter

19. A fault indicator will give a visual ____ after the high magnetic field from a fault current triggers the unit.

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flag

20. After a DC test is applied, it takes a long time to drain the charge off the cable; consequently, you should wait ____ minutes, then ground it.

15

21. When energizing a faulted cable, the high fault current generated can become a(n) ____ hazard in a confined space.

explosive

22. In some station designs where space is limited, bare conductors are suspended inside pipes that are filled with an insulating gas, ____.

HF_6, SH_6, CH_6 or SF_6

SF6

23. The limiting factor for the ampacity of cable is ____.

heat

24. The ____ layer next to the conductor is referred to as the conductor or strand shield.

semiconductor

25. Line work, whether overhead or underground, is all about working with _____.

conductors

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Three-phase Transformer Connections - Part 1 Module

Assignment: Read Chapter 14 - Transformation for Lineworkers.

PowerPoint: None

Quiz: Three-phase Transformer Connections - Part 1

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Build Three-phase Banks to Standard Module

Assignment: Read Chapter 16

PowerPoint: None

Quiz: Build Three-phase Banks to Standard

1. When mounting a transformer directly to a pole, why is it important to space mounting bolts slightly farther apart vertically than the holes in the mounting bracket? (pg. 218)

Spreading the transformer bolts allows the top bolts to completely bottom out in the upper mounting slot. This insures that the anti-jump feature of the upper mounting bracket will be effective in mitigating against dislodging of the transformer during impacts against the pole. (pg. 218)

2. Due to the high usage of salvaged transformers (particularly for 7.2/12 kV and lower voltages), there exists a considerable proliferation of different transformer styles and bushing arrangements. Also, transformers recycled from a previous installation may have internal wiring changes that do not apply to your installation. Therefore, it is important that, with each transformer installation, the bushings are properly identified by referring to the [a] and that the applicable [b] are followed precisely. (pg. 218)

a. nameplate
b. connection diagrams

3. Why should you avoid using up surplus transformers by paralleling instead of installing one new transformer with higher capacity?

The losses of two smaller transformers are greater then the losses of one larger transformer. Paralleling of transformers also introduces a safety hazard to workers because of back feed possibilities. (pgs. 123, 128 and 228)

4. Transformers with [a] primary bushings are suitable for any connection, whereas transformers with [b] primary bushing can only be connected phase to ground.

a. two
b. one

5. What type of lead should be used to drop from the main line to the cutout and how should it be safely positioned?

The drop-lead from the main line to the cutout is #4 bare soft drawn copper. This lead should be located so that side sway will not cause contact with other objects and should not be curled. (pg. 218)

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6. What is different about the type of lead that continues the connection between the cutout and the transformer? What is the purpose of this difference and how does it affect approach distances?

The drop lead from the cutout to the transformer is #4 polyethylene covered copper which provides bird protection. This conductor does not have fully rated insulation and, therefore,limits of approach must be maintained as if it were bare. (pg. 218)

7. When might it be more economical to use open-Y – open-Δ and what are the disadvantages?

For small three phase 240 volt delta loads where voltage regulation is not important, it may be more economical to use two 10 kVA transformers (instead of three) in an open wye - open delta configuration. Note that voltage regulation is poor and the rated capacity is reduced to 87% of the two transformers. (pg. 219)

8. When should an open-Y–open-Δ only be used for emergencies?

The open-wye – open-delta configuration should only be used in emergency situations for transformers larger than 10 kVA. (pg. 219)

9. List 6 items you should check before installing a transformer.

1. Operate the dual voltage switch (if present) and leave it in the correct position.
2. Check winding continuity with either an ohm meter or continuity tester.
3. Check that nothing is broken or cracked.
4. Check that the weight is not too much for the pole.
5. Check that the paint finish is not seriously chipped.
6. If the installation is 120/208 volt secondary, check that the internal secondary winding leads are correctly connected for parallel winding operation. On transformers with 4 secondary bushings, confirm open circuit X2 and X3 terminals with a 500 V insulation tester. (pg. 219)

10. After installing a transformer, what should you check before connecting secondary leads and energizing the customer's service?

Prior to connecting secondary drop leads or service, energize transformer(s) and check that secondary voltage is correct. (pg. 219)

11. What is does the term "transformer polarity" refer to, and what is the most common polarity for distribution transformers?

Transformer polarity refers to phasing of the secondary voltage with respect to the primary voltage. If the two are in-phase the polarity is additive and if the two are out-of-phase the polarity is subtractive.
Essentially all single-phase distribution transformers have additive polarity, whereas single-phase power transformers have subtractive polarity. (pg. 226)

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12. Transformers with 120/240 volt secondary usually have [a] secondary bushings if they are under [b] kVA and [c] secondary bushings if they are over [d] kVA.

a. 3
b. 50
c. 3
d. 50

13. In most distribution systems, what is the common method for grounding equipment?

Grounding rod

14. Why is it generally not economically to parallel transformers?

In general, connecting transformers in parallel is not an economical procedure. The losses of two small transformers are more than the losses of the one transformer that they replace.
Also, if one transformer is out of service for any reason (for example, faulty secondary connection) the other transformer may be damaged by overloading. (pg. 228)

15. What could cause paralleling to overload one of the transformers, even though the load on the bank is less than total capacity of the bank?

Ideally, transformers in parallel should share the load in proportion to their kVA ratings. Proportional load division will occur if the turns ratios are equal and if the percent impedances are equal. If the percent impedances are unequal, disproportionate load sharing will result. (pg. 228)

16. What is the correct definition for banking and how does it differ from normal paralleling? List two hazards of a true banked configuration.

An extension of paralleled transformers has the units spaced several spans apart. This arrangement is usually called banking. Banking creates an operating hazard in that it is necessary to isolate both the primary and secondary sides of a transformer to de-energize it. Also to de-energize the secondary, it is necessary to identify and isolate all transformers connected to the secondary. (pg. 229)

17. List four advantages of a four wire grounded secondary system.

Four wire grounded systems are generally preferable to three wire ungrounded systems because the grounded system provides better ground fault protection, reduces the possibility of abnormally high voltages developing during fault conditions, and provides a greater degree of safety for operating personnel. Four wire systems can supply a mix of single-phase and three-phase with no metering or load balance problems. In addition, ferroresonance is eliminated with this connection.

Voltage feedback is less likely with this connection, but still possible. (pg. 232)

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18. If in an emergency a three wire primary Y-Δ needs to be switched to an open configuration, what extra connection is necessary? Besides emergencies, when else would this configuration be useful?

Since the wye-delta normally operates with an isolated primary star-point, the starpoint would have to be grounded if the bank was converted to an open wye-open delta connection. The wye-delta connection is useful in areas where only two phases are available, and a three-phase service is required. The grounded primary connection eliminates ferroresonance and feedback problems. (pg. 238)

19. How many cutouts must be open on a three-phase circuit to isolate just one phase?

Even if only one phase needs to be isolated, it is necessary to open all three cutouts. This is due to the voltage impressed on the "isolated" phase through the other two primary windings. (pg. 235)

20. When using 3 single phase transformers for a wye-delta bank, are two primary bushings required on each transformer?

Yes. In a wye-delta bank the star-point is floating and this allows a voltage on the neutral when one phase is lost. (pg. 234)

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Apply Transformer Connections - Part 1 Module

Assignment: Read Chapter 17 - Apply Transformer Connections

PowerPoint: None

Quiz: None

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Apply Transformer Connections - Part 2 Module

Assignment: Read chapter 17 (pages 231-245) in Transformation for Lineworkers. Review chapters 14-17 in Transformation for Lineworkers to prepare for mid-term.

PowerPoint: None

Quiz: Apply Transformer Connections

1. What is does the term “transformer polarity” refer to, and what is the most common polarity for distribution transformers?

Transformer polarity refers to phasing of the secondary voltage with respect to the primary voltage. If the two are in-phase the polarity is additive and if the two are out-of-phase the polarity is subtractive.

Essentially all single-phase distribution transformers have additive polarity, whereas single-phase power transformers have subtractive polarity. (pg. 226)

2. Transformers with 120/240 volt secondary usually have [a] secondary bushings if they are under [b] kVA and [c] secondary bushings if they are over [d] kVA.

a. 3
b. 50
c. 4
d. 50

3. In most distribution systems, what is the common method for grounding equipment?

A ground rod and the base of a transformer pole. The standard practice at most utilities is to connect all transformer tanks to a driven ground rod at the base of the transformer pole (or not more than one span away). This ground is inter-connected, via the system neutral, with all other grounds on the distribution system. In fact, it is standard practice to ground all metal tanks of all devices containing live equipment. (pg. 227)

4. Why is it generally not economical to parallel transformers?

The losses of two small transformers are more than the losses of the one transformer that they replace. Also, if one transformer is out of service for any reason (for example, faulty secondary connection) the other transformer may be damaged by overloading. (pg. 228)

5. What could cause paralleling to overload one of the transformers, even though the load on the bank is less than total capacity of the bank?

Ideally, transformers in parallel should share the load in proportion to their kVA ratings. Proportional load division will occur if the turns ratios are equal and if the percent

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impedances are equal. If the percent impedances are unequal, disproportionate load sharing will result. (pg. 228)

6. How would you check for parallel overload and what rule of thumb would protect you from an overload situation?

As a rule of thumb, if the percent impedances differ by more than 7.5%, serious overloading of one of the transformers will occur (i.e. the ratio of the higher impedance to the lower impedance should not exceed 1.075). (pg. 228)

7. If you parallel the three transformers in the table below:

Transformer	Rating	Impedance(Z)
T1	167kVA	3.0%
T2	250kVA	3.6%
T3	100kVA	2.5%

What would the load be in each transformer? [a]. What would be the total kVA of the bank? [b]. Which transformer would limit the safe operational load of the bank? [c]. Calculate the appropriate load limit for this bank [d]

a. T1=155.9 kVA, T2=194.4 kVA, T3=244.0 kVA
b. 574.3 kVA
c. T1 limits the total load of the bank due to its low impedance
d. Setting the total bank impedance to the impedance of the lowest transformer (T3) gives a total safe load for the bank of 512.8 kVA.

8. What is the correct definition for banking and how does it differ from normal paralleling? List two hazards of a true banked configuration.

An extension of paralleled transformers has the units spaced several spans apart. This arrangement is usually called banking. Banking creates an operating hazard in that it is necessary to isolate both the primary and secondary sides of a transformer to de-energize it. Also to de-energize the secondary, it is necessary to identify and isolate all transformers connected to the secondary. (pg. 229)

9. List four advantages of a four wire grounded secondary system.

Four wire grounded systems are generally preferable to three wire ungrounded systems because the grounded system provides better ground fault protection, reduces the possibility of abnormally high voltages developing during fault conditions, and provides a greater degree of safety for operating personnel.

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Four wire systems can supply a mix of single-phase and three-phase with no metering or load balance problems. In addition, ferroresonance is eliminated with this connection. Voltage feedback is less likely with this connection, but still possible. (pg. 232)

10. If in an emergency a three wire primary Y-Δ needs to be switched to an open configuration, what extra connection is necessary? Besides emergencies, when else would this configuration be useful?

Since the wye-delta normally operates with an isolated primary star-point, the starpoint would have to be grounded if the bank was converted to an open wye-open delta connection. The wye-delta connection is useful in areas where only two phases are available, and a three-phase service is required. The grounded primary connection eliminates ferroresonance and feedback problems. (pg. 238)

11. How many cutouts must be open on a three-phase circuit to isolate just one phase?

Even if only one phase needs to be isolated, it is necessary to open all three cutouts. This is due to the voltage impressed on the "isolated" phase through the other two primary windings. (pg. 235)

12. When using 3 single-phase transformers for a wye-delta bank, are two primary bushings required on each transformer?

Yes. In a wye-delta bank the star-point is floating and this allows a voltage on the neutral when one phase is lost. (pg. 234)

13. The star-point of a 3-transformer wye-delta bank is inadvertently grounded during installation. Subsequently, one phase of the 3-phase supply circuit breaks during a storm. Describe what happens at the transformer bank because of the broken supply phase.

The two transformers connected to the 2 remaining supply phases operate as an open wye – open delta bank.

• Customer service is maintained but capacity is reduced to 57.7% of the original bank or 86.6% of the remaining two. It is possible the transformers will burnout due to overload.

• The transformer connected to the broken phase is back-fed by the secondary and it energizes the broken primary phase at normal voltage. The broken phase will then supply up-line loads and this can cause the back-fed transformer to burnout due to overload.

• The energized broken phase may be a hazard to utility workers and the general public.

• The transformer bank customer and up-line customers still have service so no one calls the utility about a problem. The overloaded and hazardous condition remains until there is a transformer burnout. (pg. 234)

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Linemen 2310 Midterm Module

Assignment: Read Chapter 17 - Apply Transformer Connections, Complete Midterm Exam

PowerPoint: None

Quiz: Midterm

1. What is does the term “transformer polarity” refer to, and what is the most common polarity for distribution transformers?

Transformer polarity refers to phasing of the secondary voltage with respect to the primary voltage. If the two are in-phase the polarity is additive and if the two are out-of-phase the polarity is subtractive.

2. What could cause paralleling to overload one of the transformers, even though the load on the bank is less than total capacity of the bank?

Ideally, transformers in parallel should share the load in proportion to their kVA ratings. Proportional load division will occur if the turns ratios are equal and if the percent impedances are equal. If the percent impedances are unequal, disproportionate load sharing will result. (pg. 228)

3. If in an emergency a three wire primary Y-Δ needs to be switched to an open configuration, what extra connection is necessary? Besides emergencies, when else would this configuration be useful?

Since the wye-delta normally operates with an isolated primary star-point, the starpoint would have to be grounded if the bank was converted to an open wye-open delta connection. The wye-delta connection is useful in areas where only two phases are available, and a three-phase service is required. The grounded primary connection eliminates ferroresonance and feedback problems. (pg. 238)

4. The star-point of a 3-transformer wye-delta bank is inadvertently grounded during installation. Subsequently, one phase of the 3-phase supply circuit breaks during a storm. Describe what happens at the transformer bank because of the broken supply phase.

The two transformers connected to the 2 remaining supply phases operate as an open wye – open delta bank.

• Customer service is maintained but capacity is reduced to 57.7% of the original bank or 86.6% of the remaining two. It is possible the transformers will burnout due to overload.

• The transformer connected to the broken phase is back-fed by the secondary and it energizes the broken primary phase at normal voltage. The broken phase will then supply up-line loads and this can cause the back-fed transformer to burnout due to overload.

• The energized broken phase may be a hazard to utility workers and the general public.

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• The transformer bank customer and up-line customers still have service so no one calls the utility about a problem. The overloaded and hazardous condition remains until there is a transformer burnout.
(pg. 234)

5. Why is it generally not economical to parallel transformers?

The losses of two small transformers are more than the losses of the one transformer that they replace.

Also, if one transformer is out of service for any reason (for example, faulty secondary connection) the other transformer may be damaged by overloading. (pg. 228)

6. When mounting a transformer directly to a pole, why is it important to space mounting bolts slightly farther apart vertically than the holes in the mounting bracket?

Spreading the transformer bolts allows the top bolts to completely bottom out in the upper mounting slot. This insures that the anti-jump feature of the upper mounting bracket will be effective in mitigating against dislodging of the transformer during impacts against the pole.(pg. 218)

7. Why should you avoid using up surplus transformers by paralleling instead of installing one new transformer with higher capacity?

The losses of two smaller transformers are greater than the losses of one larger transformer. Paralleling of transformers also introduces a safety hazard to workers because of back feed possibilities. (pgs. 123, 128 and 228)

8. List 6 items you should check before installing a transformer.

1. Operate the dual voltage switch (if present) and leave it in the correct position.

2. Check winding continuity with either an ohm meter or continuity tester.

3. Check that nothing is broken or cracked.

4. Check that the weight is not too much for the pole.

5. Check that the paint finish is not seriously chipped.

6. If the installation is 120/208 volt secondary, check that the internal secondary winding leads are correctly connected for parallel winding operation. On transformers with 4 secondary bushings, confirm open circuit X2 and X3 terminals with a 500 V insulation tester. (pg. 219)

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9. After installing a transformer, what should you check before connecting secondary leads and energizing the customer's service?

Prior to connecting secondary drop leads or service, energize transformer(s) and check that secondary voltage is correct. (pg. 219)

10. Splices, terminations, and connections, especially for large conductors, are compressed onto a conductor with hydraulic presses and ____.

dies

11. A ____ conductor is an arrangement of conductors in which each phase has two or more conductors in parallel.

bundled

12. ____ is the current in amperes that a conductor can carry continuously without exceeding its temperature rating.

Ampacity

13. When working with fiber optic cable, a ____ is necessary because any pulling tension will cause twisting forces on the cable.

swivel pulling eye

14. Fiber optics use ____ to transmit information down glass fibers.

light pulses

15. A fault on a secondary underground cable often starts out as a complaint of ____.

erratic power

16. From an electrical perspective, the selection of a conductor is based on the ____ and voltage requirements of the circuit.

ampacity

17. A(n) ____ megohmmeter reading indicates a series fault where the conductor and/or neutral are burned open, or it indicates a cable without a fault.

infinity

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18. When energizing a faulted cable, the high fault current generated can become a(n) ____ hazard in a confined space.

explosive

19. The limiting factor for the ampacity of cable is ____.

heat

20. The ____ layer next to the conductor is referred to as the conductor or strand shield.

semiconductor

21. What does it mean if a transformer bank is described as Δ-Y or Y-Δ?

The symbols Δ-Y represent a bank of three transformers whose primary windings are in a delta connection and secondary windings are in a wye or star connection.The symbols Y-Δ represent a bank of three transformers whose primary windings are in a wye or star connection and secondary windings are in a delta connection. (pgs. 171, 173)

22. Describe three-phase service and the most common primary and secondary configurations.

The term, “three-phase” is applied to any current-consuming or current-carrying apparatus designed to be activated or energized by three distinct voltages or phases. A delta 3-phase system consists of three phase conductors and a wye (star) system consists of three phase conductors and a neutral. The neutral point may be a conductor or it may be a ground (earth return). Primary lines are usually three-phase 4-wire wye and secondary lines are usually three-phase three wire systems but the proportion of 4-wire wye systems is increasing. (pg. 162)

23. What is the basic “rule” for connecting 3 transformers in a wye configuration?

Connect 3 “like” terminals to a common point (wye point). The remaining 3 “like” terminals receive or supply individual phases. (pg. 163)

24. What is the basic “rule” for connecting 3 transformers in a delta configuration?

Connect 2 “unlike” terminals of two different transformers together to form each phase terminal point (3 terminal points). The 3 terminal points receive or supply individual phases. (pg. 162) Caution: Do not connect 2 “unlike” terminals of one transformer together as this would cause a short circuit.

25. What precaution is necessary when connecting a single-phase 120/240 volt service to a4-wire 240 volt delta secondary?

Avoid connecting a 120 volt load to the one 208 volt line-to-neutral position. (pg. 169)

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Calculating Load Checks on Delta and Wye Systems Module

Assignment: Read chapter 18 in Transformation for Lineworkers.

PowerPoint: None

Quiz: Calculating Load Checks on Delta and Wye Systems

1. When windings are connected in a delta configuration, how many windings contribute to the current measured in the phase conductor?

With the transformer windings connected delta, the current outside the delta will be a resultant of the currents from the two windings. (pg. 248)

2. To calculate the current in the winding(s) of one transformer in a delta bank you can divide the line current by [a].

1.73

3. Show how to calculate the load on one transformer by measuring the current inside the delta.

kVA = (current inside winding x volts phase to phase) / 1,000 = (I x E) / 1,000. (pg. 249)

4. When can you multiply one transformer's load by 3 to get the total load of a closed delta bank?

When the load is balanced across all transformers.

5. A closed delta-delta bank supplies a balanced load at 240 volts. The current outside thedelta is 721 amps. What is the current inside the delta? [a] What is the kVA load of each transformer? [b] What is the total bank load? [c]

a. 721 amps / 1.73 = 416.66 or 417 amps

b. kVA = E x I (inside) / 1000
kVA = 2420 x 417 / 1000 = 100 kVA per transformer

c. 3 x 100 KVA = 300 kVA

6. When could you find unbalanced loads on delta secondary systems?

When one transformer of a 240 volt delta bank supplies a single phase 120/240 volt circuit in addition to its component of the three phase load. (pg. 172). When a customer installs one dry type 480 – 120/240 volt transformer and connects it across two phases of a 480 volt delta secondary. (experience)

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7. How should transformer load calculations be done when a delta 3-phase secondary circuit is unbalanced?

Use the single phase method for each transformer, kVA = E x I (inside) / 1000. This allows you to determine if any transformer is overloaded. (pg. 249)

8. Why is it best to calculate the load on each transformer separately when calculating thetotal load on a wye (star) bank?

Each transformer can vary considerably because each one supplies a single-phase load and its component of the 3-phase load. For this reason when calculating total bank load the best method is to calculate individual transformer loads and add them together. (pg. 249)

9. What formula is used to calculate the load on one wye-connected transformer?

kVA = [winding current x volts (phase to neutral)] / 1,000 = (I x E) / 1,000. (pg. 250)
Pg. 250

10. A bank of three 100 kVA transformers supplies a 4-wire 120/208 volt service. Individual transformer load currents are: Transformer #1 = 908 amps. Transformer #2 = 812 amps. Transformer #3 = 794 amps.

What is kVA load of each transformer [a] What is the total bank kVA? [b] Is any transformer overloaded? [c] Can anything be done in the field if one transformer of wye bank is consistently overloaded? [d]

a. #1 kVA = 120 x 908 / 1000 = 109 kVA, #2 kVA = 120 x 812 / 1000 = 97.5 kVAxt, #3 kVA = 120 x 794 / 1000 = 87 kVA
b. 908 + 97.5 + 87 = 293.5 kVA
c. Yes, Transformer 1 Answer Text
d. Yes, transfer to the under-loaded
pg. 250

11. What is an alternate formula for calculating the entire load of a wye bank?

Total kVA = (average current x volts phase to phase x 1.73) / 1,000 = (I x E x 1.73) / 1,000. (pg. 250)

12. On either, a wye or delta transformer bank an overload condition may not be detected on an individual transformer if the three-phase formulas are used to calculate bank kVA. If true, then why?

True. Because individual transformer currents are averaged when three-phase formulas are used. (pgs. 249 and 250)

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13. One transformer has failed in a 3-transformer wye-wye bank. Transformers are of equalize. The two remaining transformers have been re-connected to provide emergency 3-phase wye service.

What is the available percentage of name plate capacity of the two transformers? [a]

What percentage of the original 3-transformer bank can the two remaining transformer provide? [b]

a. 75%
b. 50%
Pg. 251

14. Two 50 kVA transformers are installed in an open wye – open delta bank.

What percentage of nameplate capacity can these transformers provide in this configuration? [a]

The original wye-delta bank had three 50 kVA transformers. What percentage of the original bank capacity can the above 2-transformer bank provide? [b]

a. This bank is 87% efficient so the total load rating would be 87 kVA, or 43.5 kVA each.

b. The 2-transformer bank can only provide 58% of the original bank capacity, i.e. 87 kVA.

Pg 250-251

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Three-phase Circuits - Part 1 Module

Assignment: Review chapter 6 in Guidebook for Lineman and Cableman. (Pages 173-176).

PowerPoint: None

Quiz: None

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Three-phase Circuits - Part 2 Module

Assignment: Review chapter 6 in Guidebook for Lineman and Cableman. (Pages 173-176).

PowerPoint: None

Quiz: Three-phase Circuits

1. A(n) ____ system is a circuit fed from a delta-connected secondary of a three-phase transformer bank.

delta

2. A three-phase wye circuit consists of ____ wires.

four

3. A three-phase circuit starts at a(n) ____.

generator

4. ____ markers on underground cable ensure proper connection to overhead conductors.

Phasing

5. The voltage and current in each phase of a three-phase circuit are ____ second behind another phase.

1/180

6. A simplified three-phase generator has three coils mounted on the armature at ____ degrees apart.

120

7. A live conductor in a circuit is called a ____.

phase

8. For single-phase lines, the Handy Number = _____.

L - N voltage / 1,000

9. To do the power calculations quickly in the field, a ____ Number can be used for approximations.

Handy

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10. Calculations for field applications use the ____ formulas.

    kVA

11. _____power is used in the field because it is what a feeder carries

    apparent

12. Wye connections are represented on paper in the shape of a(n) "____".

    Y

13. To complete a circuit, electrical current must return to the ____.

    source

14. Electric current needs a ____ before it can flow.

    circuit

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Installing Personal Protective Grounds - Part 1 Module

Assignment: Read Chapter 13 in Guidebook for Lineman and Cableman (pages 481-497).

PowerPoint: None

Quiz: None

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Installing Personal Protective Grounds - Part 1 Module

Assignment: Read Chapter 13 in Guidebook for Lineman and Cableman (pages 498-515).

PowerPoint: None

Quiz: Installing Personal Protective Equipment

1. If a current flow is interrupted by a break in a circuit, an ____ appears across the break.

   immediate high voltage

2. Applying ____ is the ultimate test for isolation.

   protective grounds

3. On a wye system, the ____ is the best electrode.

   system neutral

4. The difference of potential between the phase and a neutral or structure can become dangerous when working more than ____ feet from the installed set of grounds.

   300

5. A grounding support stud is also known as a(n) ____ stud.

   block

6. A typical jumper ground or ground set consists of a flexible copper stranded cable covered with a jacket rated at ____ V.

   600

7. On a wye system, the protective grounds connect the phases to the ____.

   neutral

8. ____ must be installed so that a worker is kept in an Equipotential zone

   Bonds

9. A ____ mat bonded to the protective grounds will keep a worker within an Equipotential zone.

   ground-gradient

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10. A ____ tool will confirm that a cable is isolated.

spiking

11. On live-front equipment, the ____ side of the switchgear is exposed and somewhat accessible to protective grounds that have clamps suited to the equipment to be grounded.

load

12. A ____ is typically used to ground a three-phase feeder at a dead-front switching cabinet.

protective ground set

13. Underground cable is a ____ that can maintain a charge for a long time.

capacitor

14. Grounding all three phases results in ____ in the case of re-energization.

fast clearing

15. Protective ____ are installed to reduce any current flow through a worker to an acceptable level by providing a low-resistance parallel shunt around the worker.

grounds

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Three-phase Circuits - Part 3 Module

Assignment: Review chapter 6 in Guidebook for Lineman and Cableman. (Pages 173-176).

PowerPoint: None

Quiz: None

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Three-phase Transformer Connections - Part 2

Assignment: None

PowerPoint: None

Quiz: Three-phase Transformer Connections

1. Describe three-phase service: The term, “three-phase” is applied to any [a]-consuming or [a] -carrying apparatus designed to be activated or energized by three distinct [b] or phases.

a. current
b. voltages

2. A delta 3-phase system consists of [a]-phase conductors and a wye (star) system consists of three phase conductors and a neutral. The neutral point may be a conductor or it may be a ground (earth return). Primary lines are usually three-phase 4-wire wye and secondary lines are usually three-phase three wire systems but the proportion of 4-wire wye systems is increasing. (pg. 162)

a. three

3. What is the basic “rule” for connecting 3 transformers in a wye configuration?

Connect 3 “like” terminals to a common point (wye point). The remaining 3 “like” terminals receive or supply individual phases. (pg. 163)

4. In a delta transformer bank the voltage across each winding is equal to _____ voltage.

phase to phase, phase-to-phase

5. In a delta transformer bank the [a] current is divided by 1.73 to determine the [b] current. Winding current is [c] percent of line current.

a. line
b. winding
c. 58

6. Depending on the wiring configurations of delta-delta transformer banks, the phase angle displacements between the primary and secondary could be [a] degrees or [b] degrees.

a. 0
b. 180

7. Single phase 120/240 volt service is required from a three-phase 240 volt delta bank. Can this be done? [a] If so, describe how you would proceed. [b]

a. Yes, No

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b. Connect an X2 of one transformer to the secondary neutral, Connect an X2 of one transformer to the primary neutral

8. In a delta transformer bank the voltage across each winding is equal to _____ voltage.

phase-to-phase
phase to phase

9. Depending on the wiring configurations of delta-delta transformer banks, the phase angle displacements between the primary and secondary could be [a] degrees or [b] degrees.

a. 0
b. 180

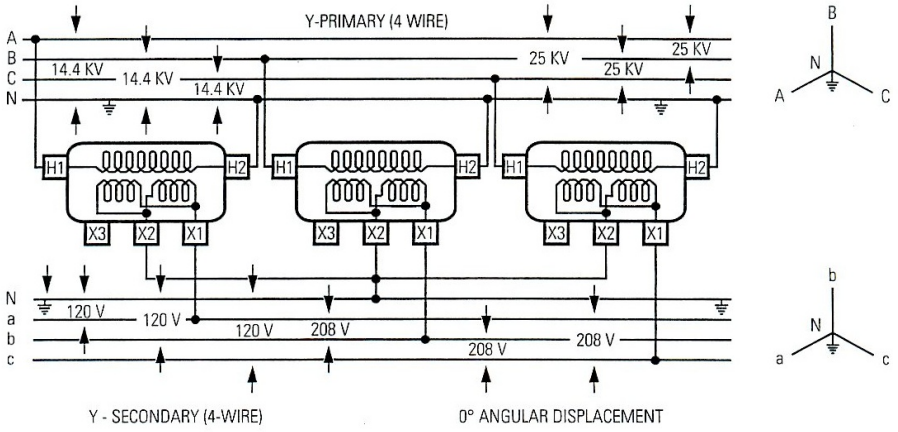
10. Single phase 120/240 volt service is required from a three-phase 240 volt delta bank. Can this be done? Yes or No? If so, describe how you would proceed.

Yes. Connect an X2 of one transformer to the secondary neutral and connect the 120/240 volt single-phase service to the neutral and hot legs of the same transformer. (pg. 169)

11. What does it mean if a transformer bank is described as Δ-Y or Y-Δ ?

The symbols Δ-Y represent a bank of three transformers whose primary windings are in a delta connection and secondary windings are in a wye or star connection. The symbols Y-Δ represent a bank of three transformers whose primary windings are in a wye or star connection and secondary windings are in a delta connection. (pgs. 171, 173)

12. This is a diagram of a 3-phase 3 transformer wye-wye bank. True or False



True

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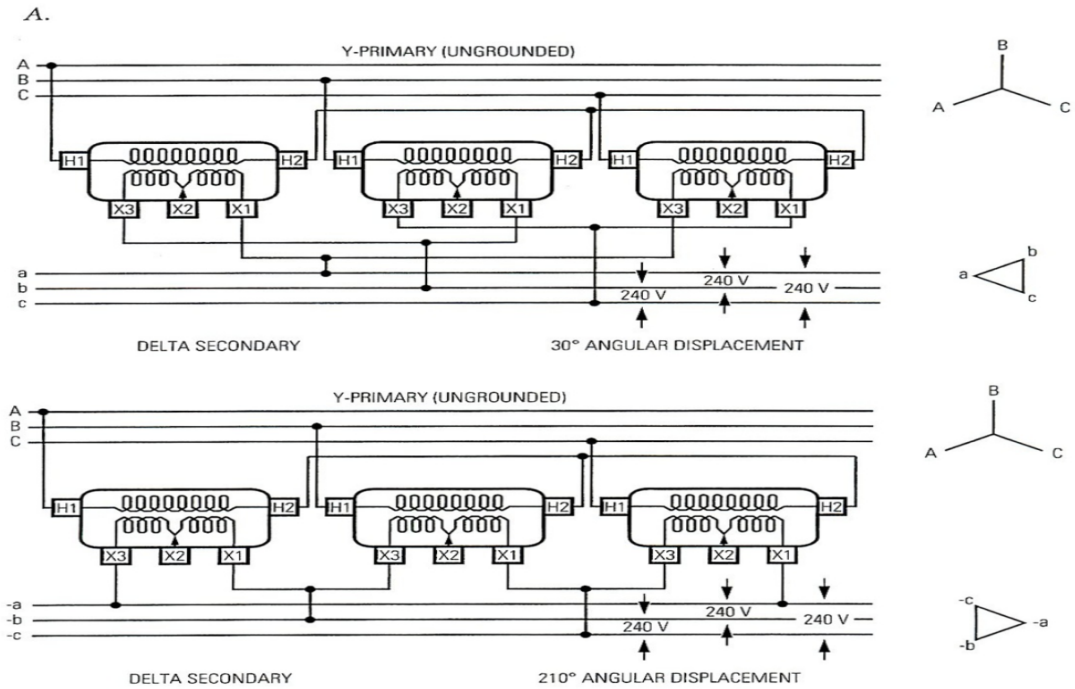
13. Primary and secondary neutrals on wye-wye banks must always be grounded to maintain voltage stability.

True

14. In wye-wye transformer banks it is possible to have phase angle displacements between the primary and secondary of [a] degrees or [b] degrees depending on wiring configurations.

a. 0
b. 180



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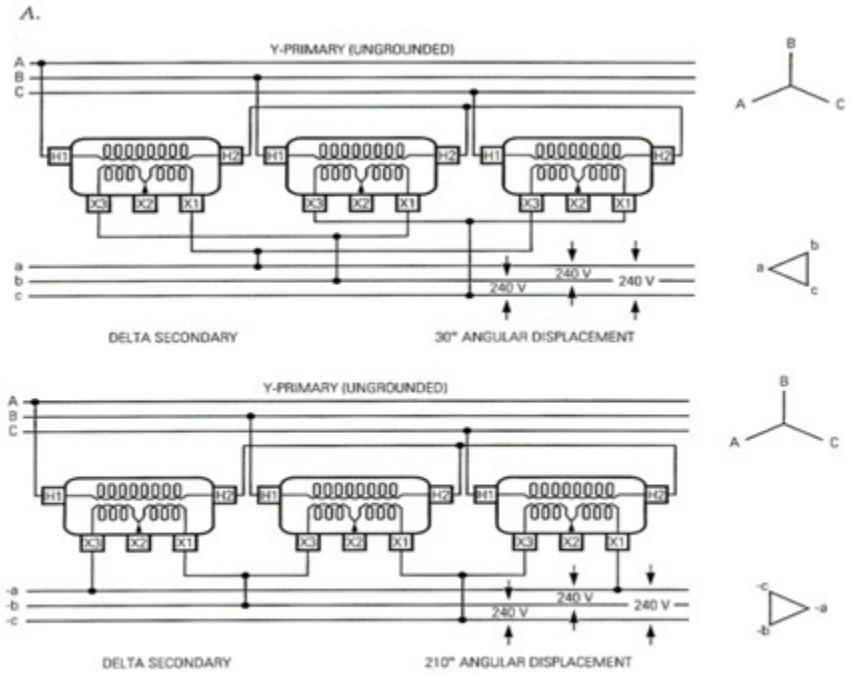
15. The following diagram illustrates the connection for a 3-transformer wye-delta bank. Wye-delta banks may be connected for either a [a] degree or [b] degree phase angle displacement between the primary and secondary.



a. 30
b. 210

16. One a three-transformer wye-delta bank, the wye point is normally grounded. True or False?

False

17. The output or secondary type of connections (used, closed or open wye or delta), dictate the applicable percentages of capacity available. True or False?

True

18. Describe a three-phase transformer: Three-phase transformers have the [a] and [b]-voltage windings of all three-phases mounted inside one tank and the magnetic circuits of the three-phases are interlinked in the same core. (pg. 168)

a. high
b. low

19. Describe an autotransformer, using the names of its windings: Instead of the two separate windings as seen in a typical distribution transformer, the autotransformer has its windings connected in [a] forming one winding with two parts. The part between the load connections is

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called the [b] winding and the part of the winding outside the load connections is called the [c] winding. (pgs. 169 and 170)

a. series
b. common
c. series

20. The primary advantage an autotransformer possesses is that only a portion of the power is transferred by [a] while the rest flows directly from the primary lines to the secondary lines without transformation.

a. Electromagnetic Induction

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Linemen 2310 Final Module

Assignment: Complete Final Exam

PowerPoint: None

Exam: Final

1. When windings are connected in a delta configuration, how many windings contribute to the current measured in the phase conductor?

With the transformer windings connected delta, the current outside the delta will be a resultant of the currents from the two windings. (pg. 248)

2. When can you multiply one transformer's load by 3 to get the total load of a closed delta bank?

When the load is balanced across all transformers. (pg. 249)

3. A closed delta-delta bank supplies a balanced load at 240 volts. The current outside the delta is 721 amps. What is the current inside the delta? [a] What is the kVA load of each transformer? [b] What is the total bank load? [c]

a. 721 amps / 1.73 = 416.66 or 417 amps
b. kVA = E x I (inside) / 1000, kVA = 2420 x 417 / 1000 = 100 kVA per transformer
c. 3 x 100 KVA = 300 kVA

4. What formula is used to calculate the load on one wye-connected transformer?

kVA = [winding current x volts (phase to neutral)] / 1,000 = (I x E) / 1,000. (pg. 250)
kVA = [winding current x volts (phase to neutral)] / 1,000 = (I x E) / 1,000. (pg. 250)

5. What is an alternate formula for calculating the entire load of a wye bank?

Total kVA = (average current x volts phase to phase x 1.73) / 1,000 = (I x E x 1.73) / 1,000. (pg. 250)

6. One transformer has failed in a 3-transformer wye-wye bank. Transformers are of equal size. The two remaining transformers have been re-connected to provide emergency 3-phase wye service. What is the available percentage of name plate capacity of the two transformers? [a] What percentage of the original 3-transformer bank can the two remaining transformer provide? [b]

a. 75% pg. 251
b. 50%

7. A three-phase wye circuit consists of ____ wires.

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four

8. ____ markers on underground cable ensure proper connection to overhead conductors.

Phasing

9. A live conductor in a circuit is called a ____.

phase

10. For single-phase lines, the Handy Number = ____

L - N voltage / 1,000

11. ____ power is used in the field because it is what a feeder carries.

Phased

12. If a current flow is interrupted by a break in a circuit, an ____ appears across the break.

immediate high voltage

13. Applying ____ is the ultimate test for isolation.

protective grounds

14. On a wye system, the ____ is the best electrode.

system neutral

15. ____ must be installed so that a worker is kept in an Equipotential zone.

Bonds

16. A ____ is typically used to ground a three-phase feeder at a dead-front switching cabinet.

protective ground set

17. Protective ____ are installed to reduce any current flow through a worker to an acceptable level by providing a low-resistance parallel shunt around the worker.

grounds

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LINEMEN - 2320 3B

	Instructional Summary
Course Description	Student will; Learn about Transformers, Supplying Quality Power, APPA Safety Manual, Phasing and Paralleling Three-phase Circuits, Operating Switchgear, Circuit Protection, Lockout/Tagout
Student Learning Outcome	Student will; Describe the Purpose of Transformer and the Different Types of Connections and Arrangements, Describe the Factors That Affect Voltage in a Circuit, Explain Distributi9on in Substation Voltage and Feeder Voltage. Understand and Apply Safety Protocols as Outlined in the APPA Safety Manual. Demonstrate Phasing and Paralleling by Connecting Transformers Together, Perform Three-phase Load Calculations, Understand the Benefits of System Grounding for Protection, Demonstrate Proper Lockout/tag out Procedures with Breakers
Instructional Activity	In-Class Lectures Interactive/Demo Labs Online Assignments & Assessments
Material/Equipment	Keys for Lab Access -Miller Campus Course Access -Canvas
Duration	Course Jan 13 - May 4, 2012 (13 Weeks) Total Hours of Online Student Work (Estimate): _____ Total Hours of Online Instructor Work (Estimate): _____
Notes	Point of Contact: Online- Karma Wayman x5391 Program- Ashley Sokia x5354

(For additional details see the course syllabus.)

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Class Introduction Module

Assignment: Watch video & change your email

PowerPoint: None

Quiz: Practice

1. Which course are you taking?

   Lineman 3B

2. True or False: You have downloaded your class syllabus.

   True

3. How do you change your e-mail and notification settings for your online class?

   Profile link in the top right hand corner

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The Purpose of a Transformer - Part 1 Module

Assignment: Read Chapter 14 in Guidebook for Lineman and Cableman (pgs 517-562).

PowerPoint: None

Quiz: The Purpose of a Transformer

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The Purpose of a Transformer - Part 2 Module

Assignment: Read Chapter 14 in Guidebook for Lineman and Cableman (pages 562-579).

PowerPoint: None

Quiz: The Purpose of a Transformer

1. The transformer ratio is calculated using the equation _____.

   input/output = transformer ratio

2. The power carried in a circuit is equal to _____.

   volts x amperes

3. Distribution transformers with taps typically have tap settings that raise or lower the voltage ____% for each tap.

   2.5

4. Whether the transformer is additive or subtractive is based on the ____ of the coil winding.

   direction

5. The terminals of a transformer have a fixed ____ in relation to other terminals.

   polarity

6. A ____ test will ensure that there are no shorts between turns in the windings.

   ratio

7. Regardless of the turns ratio, and ignoring some transformer losses, the energy input into the transformer is ____.

   equal to the energy output

8. A ____ is an electromagnetic device that provides a magnetic linkage between two electrical circuits.

   transformer

9. When a single-wire earth return (SWER) system is feeding a transformer, then the pole/down ground is the primary ____.

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neutral

10. Ferro resonance can cause the voltage on a circuit to increase from two to ____ times, causing equipment damage.

nine

11. When the primary of the transformer is opened, the primary terminal will remain energized because of ____ from the energized secondary.

backfeed

12. ____ are high-capacity fuses designed and fused to blow before the cable insulation is damaged by heat from excessive current feeding a fault.

Limiters

13. In the American system, one three-phase transformer is used to feed about ____ times the length of a typical single-phase secondary bus for a given load and for the same voltage drop limitation.

eight

14. The ____ transformer is used to reduce the voltage on local distribution lines to a utilization voltage.

distribution

15. Most people worldwide use the ____ distribution system to feed utilization voltages to the customers.

European

16. A ____ is a tapped autotransformer that can regulate voltage under loaded conditions.

voltage regulator

17. ____ transformers are potential transformers and current transformers that reduce voltage and current to lower, manageable levels.

Grounding

18. A ____ transformer is used as an indirect way to ground one phase of a delta circuit.

grounding

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19. A ____ transformer is one that is used where telecommunications (telephone) cable enters a substation.

neutralizing

20. A three-phase service supplied to a customer should not have a voltage imbalance exceeding ____%.

1

21. When two or more transformers are connected in a(n) ____ configuration, the coils are connected in series with each other.

delta

22. A ground wire is a ____

grounding conductor

23. The ____ ratio of a transformer determines the ratio between the primary voltage and the secondary voltage.

turns

24. When single-phase transformers are to be connected in parallel or connected into a three-phase bank, it is normal to select transformers with the same ____.

polarity

25. Network transformers are ____-phase units.

three

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Supplying Quality Power - Part 1 Module

Assignment: Read Chapter 15 in Guidebook for Linemen and Cablemen (pgs 598-627).

PowerPoint: None

Quiz: None

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Supplying Quality Power - Part 2 Module

Assignment: Read Chapter 15 in Guidebook for Lineman and Cableman (pgs. 598-627).

PowerPoint: None

Quiz: Supplying Quality Power

1. The amount of ____ in a circuit adds to the total impedance of the circuit.

reactance

2. ____ refers to the indirect method of keeping voltage at a proper level.

Voltage regulation

3. The ____ setting allows some variation from the actual desired voltage setting.

bandwidth

4. _____losses can add to the total line loss in a circuit.

Transformer

5. ____ refers to the direct method of voltage change such as changing a transformer output with transformer taps or changing the feeder voltage with line voltage regulators.

Voltage control

6. A utility can improve power quality on a feeder by installing ____, capacitors, and surge arrestors.

voltage regulators

7. The _____ mode of erratic voltage refers to disturbances between the neutral and the ground.

common

8. The ____ mode of erratic voltage refers to disturbances between phases or between the phase and the neutral.

support

9. ____ insulators on subtransmission lines have been a common source of TVI.

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Pin-type

10. The probable cause of intermittent noise is ____.

loose hardware

11. To find the existence of ____ voltage, connect an AC/DC voltmeter between the neutral and remote earth.

tingle

12. ____ voltage refers to a small voltage that is noticed by people or animals while contacting certain equipment or hardware.

Tingle

13. Resonance is most likely to occur when remotely switching single-pole devices on a high-voltage distribution underground cable feeding a transformer with a ____ primary.

delta

14. ____ usually occurs when one or two phases are disconnected from the source by a fault.

Ferro resonance

15. Any deviation in the magnitude or frequency of the ____ Hz sine wave is considered a power quality disturbance.

60

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Phasing and Paralleling Procedures for Three-phase Circuits Module

Assignment: Read Chapter 19 in Transformation for Lineworkers. Complete self-test.

PowerPoint: None

Quiz: Phasing and Paralleling Procedures for Three-phase Circuits

1. On 4-wire delta circuits you have found two sets of matching phases between two circuits. Is it necessary to take a voltage check between the final set of phases before connecting all three phase sets? If so, then why?

Absolutely! It is critical to confirm that the voltage reading between the third set of phases is zero or near zero. If this is not done and there is a phase angle displacement between the two circuits of 180 degrees then the voltage between the last set of phases would be line-to line voltage x 1.73. On 4-wire 120/240 volt circuits this would be 415 volts. (pg. 260 and 261)

2. To parallel 3-phase transformer banks, the [a] output must be the same, [b] settings must be identical, [c] (two words) of the transformers should be within 7 ½ % of each other, [d] ratings should be the same and the [e] (two words) must be the same.

a. voltage
b. tap
c. percent impedance
d. frequency
e. phase angle

3. What is the voltage rating requirement for voltmeters or phasing sticks when conducting voltage/phasing when conducting tests in preparation in preparation for paralleling circuits? Why?

Double the line-to-line voltage or higher. (pg. 260) Because double line-to-line voltages may be encountered on delta systems and double line to-neutral voltages may be encountered on wye systems. (pgs. 260 and 261)

4. In preparation for paralleling circuits, what are the first measurements that need to be taken?

Measure voltages of each circuit phase-to-phase and phase-to-neutral or ground (6 readings) and ensure that all is normal. Note: On 3-wire delta circuits it is necessary check from each phase to ground to determine if there may be an unintentional ground fault. (pg. 260)

5. Transformer banks are sometimes paralleled to avoid service disruption when a bank requires rebuild or other work. What precaution is necessary before isolating the bank that requires work?

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When secondary circuits are paralleled for the purpose of maintaining service, it is necessary to conduct a load check to ensure that the remaining transformer bank can sustain the total load. This must be done before the bank that requires work is removed from service. (pg. 260)

6. On 4-wire circuits, what should be done if the neutrals are not connected?

Measure for voltage between the neutrals. If no voltage exists or nominal voltage exists, 5% of the circuit voltage or less, then connect the neutrals. This establishes a reference between the circuits. (pg. 260)

7. Describe the procedure used to find matching phases between circuits. (pgs. 260 & 261)

- After confirming each circuit normal, confirm or establish a physical reference between the circuits.
- Arbitrarily label three phases of one circuit, e.g. A1, B1, C1.
- Measure for voltage from A1 to phases on the next circuit. If you find a zero or near zero reading then you have found A2. Note these phase positions. A1 readings to the
- other two phases should read normal line-to-line voltages.
- Repeat preceding step from B1 and C1. Note each set of matching phases.
- When zero or near zero voltage readings are not found there could be a phase angle
- difference between the circuits or different transformers are connected to neutrals in bank #1 compared to bank #2.

8. On 3-wire delta circuits there are no neutrals. In addition to checking phase-to-phasevoltages what other precautionary step is necessary?

Check each phase to ground to determine if there is an unintentional ground fault and on which phase it may be if there is one. (pg. 262)

9. When conducting phasing checks you find higher than normal voltages between thetwo circuits on either wye or delta systems. What does this mean and will the circuits parallel?

It means that there is a phase angle difference between the two circuits and no, they will not parallel. (pgs. 261 and 262)

10. Describe what steps should be followed when connecting a new transformer bank to an existing secondary circuit.

To parallel a new transformer bank to an existing secondary, check the installation complete and secure the secondary hot legs in the clear. Energize the bank and proceed with the steps for paralleling. (pgs. 261 and 263)

11. While conducting voltage checks of two 4-wire delta circuits you find voltages between the phases that are lower and higher then line-to-line voltages.

What does this indicate? [a]

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Can these two secondary circuits still be paralleled? [b]

Can this condition be corrected? [c]

a. A mid-point of one transformer in each bank is connected to the secondary neutral but each of those transformers is connected to different primary phases.
b. No
c. Yes

12. It is necessary to install a reference jumper between two 3-wire Delta circuits before it is possible to determine if and how the circuits can be paralleled. True or False

True

13. All necessary tests have been completed on two circuits and indicate that the circuits may be paralleled. The circuits should only be paralleled when they are both energized. True or False

True

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Safety in Phasing Module

Assignment: Read APPA Safety Manual Section 507

PowerPoint: None

Quiz: Safety in Phasing - Section 507

1. What is the definition of "minimum approach distance."

The closest distance an employee is permitted to approach an energized or grounded object. (Page 13)

2. What is the definition of "primary voltage."

Any electrical circuit that normally operates at more than 600 volts (Page 14)

3. When working from an aerial device, it is okay to belt to an adjacent pole or structure. True or False

False

4. According to the table 5.2, find the actual minimum approach distances for the following:

0.751 to 15 KV [a], 36.1 to 46.0 KV [b], 46 to 72.5 KV [c]

a. 2'2"
b. 2'9"
c. 3'3"

4. Rubber gloves shall be worn when using an approved switch stick or live line tools for opening, closing, removing, or replacing hot clamps, fuses or fuse doors on cutouts. True or False.

True

5. The automatic reclosing feature of circuit interrupting devices shall be made inoperative before live-line work begins. True or False

True

6. When working on capacitors, the terminals shall not be short-circuited until the capacitors have been de-energized for at least [a] minutes.

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a. Five

7. Only those authorized to enter a substation shall be permitted to do so. True or False

True

8. Movement of vehicles, gin poles, cranes, and other hoisting or mechanized equipment, shall be controlled by a signal man or a flag man in a substation. True or False

True

9. When work is performed in the vicinity of exposed, energized parts of equipment or lines, employees shall remove all exposed conductive articles, such as keys, watches, and rings. True or False

True

10. A fresh air breathing apparatus, body harness, and lifeline monitored by a properly trained attendant is required when working _____.

in a bucket truck

11. Compressed gas bottles can be taken into a confined space. True or False

False

12. When dealing with confined spaces, what does lock/out tag/out mean?

Before employees are allowed to enter a confined space, all electrical and mechanical energy sources that could affect the employee working in the space shall be physically rendered inoperative, locked out, and tagged.

13. What is a Hold Card?

A card or tag type device usually having a predominant color of white or red, which warns or cautions against the operation of a particular switch, device, circuit, tool, machine, etc.

14. A Hold Card can only be removed by authorization of the person whose name it was placed. True or False

True

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15. What authority does the system operator have for switching and clearances on lines?

The system operator has the authority and responsibility for switching and clearances on lines, cables, stations and equipment of 600V or above or 35 kV and lower voltages

16. DANGER DO NOT OPERATE tags are orange and must be retained for at least 2 years.

False

17. Tags will have an attachment point with a breaking strength of at least 50 Lbs. True or False

True

18. Which of the following is NOT on a DO NOT OPERATE tag for obtaining clearance.

Name of employee of the work who is requiring clearance

19. You must request a hold tag before performing hotline work on lines 35 kV and higher. True or False

True

20. Employee requests a HOLD tag before beginning hot-line work on lines of 55 kV or higher. True or False

True

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Linemen 2320 Midterm

1. To parallel 3-phase transformer banks, the [a] output must be the same, [b] settings must be identical, [c] (two words) of the transformers should be within 7 ½ % of each other, [d] ratings should be the same and the [e] (two words) must be the same.

a. voltage
b. tap
c. percent impedance
d. frequency
e. phase angle

2. In preparation for paralleling circuits, what are the first measurements that need to be taken?

Measure voltages of each circuit phase-to-phase and phase-to-neutral or ground (6 readings) and ensure that all is normal. Note: On 3-wire delta circuits it is necessary check from each phase to ground to determine if there may be an unintentional ground fault. (pg. 260)

3. Transformer banks are sometimes paralleled to avoid service disruption when a bank requires rebuild or other work. What precaution is necessary before isolating the bank that requires work?

When secondary circuits are paralleled for the purpose of maintaining service, it is necessary to conduct a load check to ensure that the remaining transformer bank can sustain the total load. This must be done before the bank that requires work is removed from service. (pg. 260)

4. On 4-wire circuits, what should be done if the neutrals are not connected?

Measure for voltage between the neutrals. If no voltage exists or nominal voltage exists, 5% of the circuit voltage or less, then connect the neutrals. This establishes a reference between the circuits. (pg. 260)

5. All necessary tests have been completed on two circuits and indicate that the circuits may be paralleled. The circuits should only be paralleled when they are both energized. True or False

True

6. The transformer ratio is calculated using the equation _____.

input/output = transformer ratio

7. Distribution transformers with taps typically have tap settings that raise or lower the voltage ____% for each tap.

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2.5

8. A ____ test will ensure that there are no shorts between turns in the windings.

ratio

9. A ____ is an electromagnetic device that provides a magnetic linkage between two electrical circuits.

transformer

10. When the primary of the transformer is opened, the primary terminal will remain energized because of ____ from the energized secondary.

backfeed

11. The ____ transformer is used to reduce the voltage on local distribution lines to a utilization voltage.

distribution

12. A ____ is a tapped autotransformer that can regulate voltage under loaded conditions.

voltage regulator

13. ____ transformers are potential transformers and current transformers that reduce voltage and current to lower, manageable levels.

Grounding

14. A three-phase service supplied to a customer should not have a voltage imbalance exceeding ____%.

1

15. When two or more transformers are connected in a(n) ____ configuration, the coils are connected in series with each other.

delta

16. The ____ ratio of a transformer determines the ratio between the primary voltage and the secondary voltage.

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turns

17. The amount of ____ in a circuit adds to the total impedance of the circuit.

reactance

18. ____ refers to the indirect method of keeping voltage at a proper level.

Voltage regulation

19. _____losses can add to the total line loss in a circuit.

Transformer

20. ____ refers to the direct method of voltage change such as changing a transformer output with transformer taps or changing the feeder voltage with line voltage regulators.

Voltage control

21. The probable cause of intermittent noise is ____.

loose hardware

22. ____ voltage refers to a small voltage that is noticed by people or animals while contacting certain equipment or hardware.

Tingle

23. Resonance is most likely to occur when remotely switching single-pole devices on a high-voltage distribution underground cable feeding a transformer with a ____ primary.

delta

24. Any deviation in the magnitude or frequency of the ____ Hz sine wave is considered a power quality disturbance.

60

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Operating Switchgear - Part 1 Module

Assignment: Read Chapter 11 in Guidebook for Linemen and Cablemen (pgs 383-399).

PowerPoint: None

Quiz: None

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Operating Switchgear - Part 2 Module

Assignment: Read Chapter 11 in Guidebook for Linemen and Cablemen (pgs 399-426).

PowerPoint: None

Quiz: Operating Switchgear

1. ____ fuses have a fusible element inside a heat-absorbing and arc-quenching material such as silica sand or borax.

Solid-material

2. A(n) ____ is extinguished by providing a fast separation of two parts of a melted fuse.

arc

3. A ____ tool can be hooked up to a fuse cutout or disconnect switch to provide a parallel path for load current through the tube of the load break tool.

load bust

4. A(n) ____ fuse link is the most common and economical fuse used in a distribution system.

expulsion-cutout

5. A ____ sectionalizer is an oil switch with a mechanism that will open automatically after a fault current goes through the coil a specified number of times.

hydraulic

6. A(n) ____ is a device that will isolate a faulted section of line when coordinated with an upstream multishot recloser or circuit breaker.

partitioner

7. A ____ tester is like a high-voltage voltmeter that has the ability to measure an approximate voltage between two different potentials on circuits over 750 V.

phasing

8. A spring-loaded ____ separates the two parts quickly when the fuse melts.

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fuse link

9. The ____-limiting will clear a fault or overload while limiting the let-through fault current to prevent damage to equipment.

current

10. The ____, plugged into a bushing, is a load break device, but it cannot interrupt a fault.

elbow

11. The ____ switchblade is an arc-quenching, load break device that is available as a current-limiting fuse or as a solid blade device.

Nx

12. The ____ test point on an elbow can be used to determine whether or not a circuit is energized.

capacitive

13. A ____ current-limiting fuse is designed to limit only high-fault currents.

thermal

14. ____ fuse will limit the magnitude of the current flow by introducing a high resistance after the fuse element melts.

current-limiting

15. ____ switchgear, such as a disconnect switch, an air break switch, or a load interrupter does not operate automatically during a fault but provides operating capability to isolate, sectionalize, or transfer loads at strategic locations.

Isolating

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APPA Safety Manual - Safety in Switching Module

Assignment: APPA Safety Manual - Section 5 - Switching and Grounding

PowerPoint: None

Quiz: APPA Safety Manual - Switching

1. When proper clearances cannot be maintained during inclement weather, rubber gloves shall be worn when making or breaking a circuit (such as switching and grounding procedures).

True

2. What should you always check before stringing parallel to an existing energized transmission line.

Check for dangerous voltage buildups and follow the provisions in 507.13 b-j to ensure proper grounding

3. Bare-wire communication conductors or structure are not considered energized lines

False

4. You can ground conductors prior to testing them for voltage.

False

5. Grounding - Equal potential grounding is required whenever possible.

True

6. When equal potential grounding is not possible, dual point grounding (bracket grounding) is acceptable.

True

7. If a line conductor is on the ground or work is being performed from an aerial device, you can use bracket grounding.

True

8. Dual point grounding is not the same as bracket grounding.

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False

9. A ground lead can be attached to either a tower ground or a driven ground.

True

10. What is a grounding electrode?

A conductor embedded in the earth, used for maintaining ground potential or conductors connected to it and for dissipating into the earth current conducted to it.

11. When using a grounding electrode, such electrodes shall have a resistance to ground low enough to permit prompt operation of protective devices.

True

12. Two employees do not need to be present when performing routine switching of circuits (if it can be done safely).

True

13. When attaching a ground to a line or to equipment, the ground-end connection shall be attached first, and then the other end shall be attached by using a live-line tool.

True

14. While switching in a distribution substation, ground trips should be cut only where an abnormal condition exists or where single-phase switching could trip the Circuit Breaker.

True

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Three-Phase Load Calculation Module

Assignment: None

PowerPoint: None

Quiz: Circuit Protection

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Circuit Protection - Part 1 Module

Assignment: Read Chapter 12 in Guidebook for Linemen and Cablemen (pgs. 452-479).

PowerPoint: None

Quiz: Circuit Protection

1. A ____ is part of the electrical circuit and is a current-carrying conductor that provides a path for current to flow back to the source.

neutral

2. A ____ grounding system refers to a multi-grounded neutral that somewhere downstream divides into two separate conductors: a neutral conductor and a ground wire.

TN-C-S

3. ____ a power system means electrically connecting the neutrals of every wye-connected transformer or generator to earth.

System grounding

4. A ____ thunderstorm occurs when a cold front meets a front of warm, moist air.

frontal

5. Many utilities have voltage conversion programs to convert their systems from typical primary voltages to higher ____ voltages.

distribution

6. A ____-delayed-instant philosophy specifies that the first trip-out operation of the source multi-shot device is delayed long enough for a downstream fuse to blow first.

time

7. The ____ scheme of the high-voltage system is divided into protective zones.

detection

8. A ____ is a low-voltage switch that is normally in either an open or closed position.

relay

9. ____ corrosion is due to a DC of external origin flowing from a metal into an electrolyte.

Stray-current

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10. Premature corrosion of metal hardware occurs when the metal becomes part of a ____.

corrosion cell

11. Measuring the ____ of a ground rod can confirm that an installation meets design requirements.

resistance

12. Soil with no moisture content would be a(n) ____.

insulator

13. A ____ fault is by far the most frequent type of fault.

line-to-ground

14. For a circuit to be complete, all the current leaving the source must ____.

return to the source

15. ____ are used to protect every part of an electrical system.

Circuit breakers

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Circuit Protection Module

Assignment: Read Chapter 12 in Guidebook for Linemen and Cablemen (pgs. 452-479).

PowerPoint: None

Quiz: Guidebook for Linemen and Cablemen Chapter 12 - Circuit Protection

1. A ____ is part of the electrical circuit and is a current-carrying conductor that provides a path for current to flow back to the source.

neutral

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14. For a circuit to be complete, all the current leaving the source must ____.

return to the source

15. ____ are used to protect every part of an electrical system.

Circuit breakers

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APPA Safety Manual - Safety with Breakers (lock-out, tag-out) Module

Assignment: None

PowerPoint: None

Quiz: APPA Safety Manual - Safety with Breakers

1. Rubber gloves shall be worn when using an approved switch stick or live line tools for opening, closing, removing, or replacing hot clamps, fuses or fuse doors on cutouts.

True

2. The automatic reclosing feature of circuit interrupting devices shall be made inoperative before live-line work begins.

True

3. When working on capacitors, the terminals shall not be short-circuited until the capacitors have been de-energized for at least [a] minutes.

five

4. Only those authorized to enter a substation shall be permitted to do so.

True

5. Movement of vehicles, gin poles, cranes, and other hoisting or mechanized equipment, shall be controlled by a signal man or a flag man in a substation.

True

6. When work is performed in the vicinity of exposed, energized parts of equipment or lines, employees shall remove all exposed conductive articles, such as keys, watches, and rings.

True

7. A fresh air breathing apparatus, body harness, and lifeline monitored by a properly trained attendant is required when working _____.

in a confined space

8. Compressed gas bottles can be taken into a confined space.

False

9. When dealing with confined spaces, what does lock/out tag/out mean?

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Before employees are allowed to enter a confined space, all electrical and mechanical energy sources that could affect the employee working in the space shall be physically rendered inoperative, locked out, and tagged.

10. What is a Hold Card?

A card or tag type device usually having a predominant color of white or red, which warns or cautions against the operation of a particular switch, device, circuit, tool, machine, etc.

11. A Hold Card can only be removed by authorization of the person whose name it was placed.

True

12. What authority does the system operator have for switching and clearances on lines?

The system operator has the authority and responsibility for switching and clearances on lines, cables, stations and equipment of 600V or above or 35 kV and lower voltages.

13. DANGER DO NOT OPERATE tags are orange and must be retained for at least 2 years.

False

The system operator has the authority and responsibility for switching and clearances on lines, cables, stations and equipment of 600V or above or 35 kV and lower voltages.

14. DANGER DO NOT OPERATE tags are orange and must be retained for at least 2 years.

False
They are red and must be retained for three years

15. Tags will have an attachment point with a breaking strength of at least 50 lbs.

True

16. Which of the following is NOT on a DO NOT OPERATE tag for obtaining clearance.

Name of employee of the work who is requiring clearance.

17. You must request a hold tag before performing hotline work on lines 35 kV and higher.

True

18. Employee requests a HOLD tag before beginning hot-line work on lines of 55 kV or higher.

True

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Linemen 2320 Final Module

1. A(n) ____ is extinguished by providing a fast separation of two parts of a melted fuse.

arc

2. A ____ tool can be hooked up to a fuse cutout or disconnect switch to provide a parallel path for load current through the tube of the load break tool.

load bust

3. A ____ sectionalizer is an oil switch with a mechanism that will open automatically after a fault current goes through the coil a specified number of times.

hydraulic

4. A(n) ____ is a device that will isolate a faulted section of line when coordinated with an upstream multishot recloser or circuit breaker.

partitioner

5. A spring-loaded ____ separates the two parts quickly when the fuse melts.

fuse link

6. A ____ fuse will limit the magnitude of the current flow by introducing a high resistance after the fuse element melts.

current-limiting

7. ____ switchgear, such as a disconnect switch, an air break switch, or a load interrupter does not operate automatically during a fault but provides operating capability to isolate, sectionalize, or transfer loads at strategic locations.

Isolating

8. Two employees do not need to be present when performing routine switching of circuits (if it can be done safely).

True

9. When proper clearances cannot be maintained during inclement weather, rubber gloves shall be worn when making or breaking a circuit (such as switching and grounding procedures).

True

10. When equal potential grounding is not possible, dual point grounding (bracket grounding) is acceptable.

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True

11. Dual point grounding is not the same as bracket grounding.

False

12. What is a grounding electrode?

A conductor embedded in the earth, used for maintaining ground potential or conductors connected to it and for dissipating into the earth current conducted to it.

13. A ____ is part of the electrical circuit and is a current-carrying conductor that provides a path for current to flow back to the source.

neutral

14. A ____ grounding system refers to a multigrounded neutral that somewhere downstream divides into two separate conductors: a neutral conductor and a ground wire.

TN-C-S

15. ____ a power system means electrically connecting the neutrals of every wye-connected transformer or generator to earth.

System grounding

16. Premature corrosion of metal hardware occurs when the metal becomes part of a ____.

corrosion cell

17. A ____ fault is by far the most frequent type of fault.

line-to-ground

18. For a circuit to be complete, all the current leaving the source must ____.

return to the source

19. ____ are used to protect every part of an electrical system.

Circuit breakers

20. Employee requests a HOLD tag before beginning hot-line work on lines of 55 kV or higher.

True

21. You must request a hold tag before performing hotline work on lines 35 kV and higher.

True

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22. Which of the following is NOT on a DO NOT OPERATE tag for obtaining clearance.

Name of employee of the work who is requiring clearance

23. Tags will have an attachment point with a breaking strength of at least 50 lbs.

True

24. DANGER DO NOT OPERATE tags are orange and must be retained for at least 2 years.

False

They are red and must be retained for three years

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LINEMEN - 2410 4A

	Instructional Summary
Course Description	Insert here
Student Learning Outcome	Insert here
Instructional Activity	In-Class Lectures Interactive/Demo Labs Online Assignments & Assessments
Material/Equipment	Keys for Lab Access -Miller Campus Course Access -Canvas
Duration	Course Jan 13 - May 4, 2012 (13 Weeks) Total Hours of Online Student Work (Estimate): _____ Total Hours of Online Instructor Work (Estimate): _____
Notes	Point of Contact: Online- Karma Wayman x5391 Program- Ashley Sokia x5354

(For additional details see the course syllabus.)

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Class Introduction Module

Assignment: Watch video & change your email

PowerPoint: None

Quiz: Practice

1. Which course are you taking?

   Lineman 4A

2. True or False: You have downloaded your class syllabus.

   True

3. How do you change your e-mail and notification settings for your online class?

   Profile link in the top right hand corner

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Live-line Maintenance with Hotline Tools Module

Assignment: Chapter 24 - Linemen and Cablemen's Handbook

PowerPoint: None

Quiz: Pages 24.1 to 24.14 Chapter 24 - Linemen and Cablemen's Handbook

1. Testing, repair and maintenance work is done on live lines more often because _____.

   workers avoid interrupting service

2. A _____ stick is a hot stick that has a fitting designed to accept a variety of interchangeable tools.

   universal

3. _____ are commonly used to lift and move conductors.

   Wire tongs

4. When electric service is interrupted, it is also called a(n) [a].

   outage

5. In general, a hot stick should be cleaned _____.

   both before and after use

6. Which of the following are typically done in a tailgate session?

   All answers listed here are correct

7. Before work begins, it is important to inspect the worksite and the tools to be used.

   True

8. Which of the following statements about a work site inspection is FALSE?

   Poles should be inspected for signs of rotting.

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9. The distance that must be kept between personnel and energized lines and equipment is referred to as the safe working distance or _____ (two words).

Minimum clearance

10. The working load limitation of a hot stick _____.

is the maximum weight that the stick can safely support

11. Match description with the appropriate tool: Tools: Universal hot stick, Wire cutter, Wire tong, Line hose, Shotgun stick

Used to cut off tie wires as they are unwrapped from a conductor [a]

Used with attachments for removing tie wires [b]

Used to hold a conductor while tie wires are removed or installed [c]

Equipped with a hook that can be used to grip equipment or other hot stick accessories [d]

A type of protective cover gear placed on a conductor or neutral to prevent contact with other equipment [e]

a. Wire cutter

b. Universal hot stick

c. Wire tong

d. Shotgun stick

e. Line hose

12. _____ (two words) is commonly used to cover the top of a pole to prevent a conductor or tie wire from accidentally coming in contact with the pole.

Pole guard

13. In some cases, if a tie wire is in bad condition, a _____ may be used to secure the conductor before any of the wires are removed.

wire tong

14. Polyethylene insulated hoods are available to place over conductors and insulators to provide safety while performing hot-stick work on an energized line.

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True

15. The clamp used to secure a wire tong is typically made in only one diameter.

False

16. Which of the following is not included in the IEEE Guide for Maintenance Methods on Energized Power Lines?

Attitude correction factor

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Live-line Maintenance from Insulated Aerial Platforms - Part 1 Module

Assignment: Read pages 24.14 to 24.33 in Chapter 24 of the Lineman's and Cableman's Handbook.

PowerPoint: None

Quiz: None

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Live-line Maintenance from Insulated Aerial Platforms - Part 2 Module

Assignment: Chapter 25 Linemen and Cablemen's Handbook

PowerPoint: None

Quiz: Live Line Maintenance

1. With the lift method, the basic procedure for moving a line is to use a wire tong to raise the line straight up. True or False

True

2. The lift method of moving a conductor requires [a] wire tong(s), while the side method requires [b] wire tong(s).

a. one
b. two

3. Two types of auxiliary arms commonly used in moving three-phase distribution lines the side arm and the _____ arm.

a. Mast

4. Which of the following is not a tool used to move distribution lines with an auxiliary arm?

Crossarm brace

5. A conductor is locked into place on a wire holder by a _____ that engages when the conductor is lowered into position.

safety latch

6. Three wire holders are mounted on an auxiliary _____arm

mast

7. When a dead-end insulator string is changed out, it _____ necessary to move the conductor out of the work area.

is not

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8. When a dead-end insulator string is changed out, tension is taken up on the line so that the insulators can be disconnected. True or False

True

9. When a dead-end insulator string is changed out, tension is taken up on the line so that the insulators can be disconnected. True or False

True

10. When a dead-end insulator string is changed out, tension is taken up on the line so that the insulators can be disconnected. True or False

True

11. A Shotgun stick can be used to install the grip, the hoist, the sling, and the link stick. True or False

True

12. It is not necessary to cover the neutral when dead-end insulators are replaced. True or False

False

13. Which of the following is not an attachment to a universal hot stick?

pliers

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Working it Hot - Part 1 Module

Assignment: Read chapter 18 (pages 705-723) in the Guidebook for Linemen and Cablemen.

PowerPoint: None

Quiz: None

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Working it Hot - Part 2 Module

Assignment: Read the rest of chapter 18 (pages 724-738) in the Guidebook for Linemen and Cablemen.

PowerPoint: None

Quiz: Working it Hot

1. A ____ clamp is used in case the workers aloft become incapacitated and the boom has to be lowered with the lower controls.

Spring-loaded breakaway

2. A(n) ____ cage is used to shield people working barehanded on high voltages.

Faraday

3. The voltage rating of rigid plastic cover-up is based on the ____.

air space between the conductor and the cover

4. The voltage range for hot-line, rubber-glove work is from 5 to ____ kV.

34.5

5. An insulated or bare jumper should be carrying at least ____% of the load current before cutting a conductor or connection.

30

6. When work requires the replacement of any circuit component, such as taps, loops, or sleeves, the component must be bypassed with a temporary ____.

jumper

7. Phasing sticks can be used to test insulators on circuits up to ____ kV.

50

8. A ____ on a hot-line tool will reduce the risk of inadvertent encroachment (choking the hot stick) into the minimum approach distance.

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hand stop

9. A ____ is where current would leave a person's body if contact were made with a hot circuit.

second point of contact

10. Because written procedures do not cover much of the details needed for work done on energized distribution lines, preparing a ____ for any jobs other than routine would demonstrate due diligence.

job safety analysis

11. A person in a conductive suit, a metal grid in the buckets, or two link sticks tied together form ____ electrodes.

floating

12. For work at the energized end of an acceptable insulator string, a bucket or worker should be positioned so that no more than ____% of the insulator string is shorted out by the buckets, worker's body, or tools.

10

13. An aerial device used for bare hand work will have a _____ contamination meter circuit built where a meter can provide continuous monitoring for leakage.

boom

14. It is quite common to retest rubber gloves as often as every ____.

2 or 3 months

15. Hot-line work generally involves work where a conductor more than ____ V is unclamped (untied), moved, cut, spliced, or solid connections are made or removed.

750

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Safety Strategies for Hot-line Work - Part 1 Module

Assignment: Study Section 507.4 Working on Energized Lines with Live-line Tools

Study Section 507.5 Working on Energized Lines Barehanded

Study Section 507.6 Working on De-energized Lines and Equipment

PowerPoint: APPA - 507 Working with Energized Live-line Tools.docx

Quiz: None

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Safety Strategies for Hot-line Work - Part 2 Module

Assignment: We will study working while energized in conjunction with the APPA Safety Manual. Read 507 Overhead Distribution and Transmission Focus on 507.1. Working on or near Energized Lines and Equipment and Minimum Approach Distance.

PowerPoint: 507 Overhead Distribution and Transmission.docx

Quiz: APPA Safety Manual Section 507

1. Only qualified employees and trainees, working under direct supervision, may work in areas containing unguarded, uninsulated energized lines or parts of equipment operating at [a] volts or more.

    a. 50

2. When working on capacitors, the terminal shall not be short-circuited until the capacitors have been de-energized for at least [a] minutes.

    a. five

3. All previously energized conductors shall be considered energized until tested and properly [a].

    a. grounded

4. What is the definition of "minimum approach distance" ?

    The closest distance an employee is permitted to approach an energized or grounded object.

5. Describe what they call either a Tailboard Safety Talk or Tailgate Job Briefing.

    A short, formal discussion of the work to be accomplished and the safety measures to be incorporated. Normally conducted by a foreman or supervisor.

6. Rubber gloves shall be worn when using an approved switch stick or live-line tools for opening, closing, removing, or replacing hot clamps, fuses or fuse doors on cutouts. True or False

    True

7. The body of a hydraulic truck must be bonded to an effective ground because it is considered energized equipment. True or False

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True

8. When proper clearances cannot be maintained during inclement weather, rubber gloves shall be worn when making or breaking a circuit (such as switching and grounding procedures). True or False

True

9. Bare-wire communication conductors or structure are not considered energized lines. True or False

False

10. Grounding - Equal potential grounding is the preferred method of grounding whenever possible. True or False

True

11. When equal potential grounding is not possible, dual point grounding (bracket grounding) is acceptable. True or False

True

12. What is a grounding electrode?

A conductor embedded in the earth, used for maintaining ground potential or conductors connected to it and for dissipating into the earth current conducted to it.

13. When using a grounding electrode, such electrodes shall have a resistance to ground low enough to permit prompt operation of protective devices. True or False

True

14. When attaching a ground to a line or to equipment, the ground-end connection shall be attached first, and then the other end shall be attached by using a live-line tool. True or False

True

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Linemen 2410 Midterm Module

Assignment: Complete Midterm Exam

PowerPoint: 4th year trans midterm doc.

Exam: Midterm

1. What is the definition of "minimum approach distance" ?

   The closest distance an employee is permitted to approach an energized or grounded object.

2. What is the definition of "primary voltage"?

   Any electrical circuit that normally operates at more than 600 volts.

3. What is the employee's responsibility for safety?

   Before beginning a job, employees shall satisfy themselves that they can perform the task without injury. If they are in doubt as to their ability to perform the work, they shall call this to the attention of their supervisor. (See Section 102, pg 24)

4. According to the table 5.2, find the actual minimum approach distances for the following: 0.751 to 15 KV [a], 36.1 to 46.0 KV [b], 46 to 72.5 KV [c]

   a. 2'2"
   b. 2'9"
   c. 3'3"

5. All previously energized conductors shall be considered energized until tested and properly [a]. (Section 507.13 a, Pg. 158)

   a. grounded

6. Rubber gloves shall be worn when using an approved switch stick or live line tools for opening, closing, removing, or replacing hot clamps, fuses or fuse doors on cutouts. True or False

   True

7. When working on capacitors, the terminals shall not be short-circuited until the capacitors have been de-energized for at least [a] minutes.

   a. five

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8. The voltage rating of rigid plastic cover-up is based on the ____.

air space between the conductor and the cover

9. The voltage range for hot-line, rubber-glove work is from 5 to ____ kV.

34.5

10. An insulated or bare jumper should be carrying at least ____% of the load current before cutting a conductor or connection.

30

11. When work requires the replacement of any circuit component, such as taps, loops, or sleeves, the component must be bypassed with a temporary ____

jumper

12. A ____ on a hot-line tool will reduce the risk of inadvertent encroachment (choking the hot stick) into the minimum approach distance.

hand stop

13. A ____ is where current would leave a person's body if contact were made with a hot circuit.

second point of contact

14. For work at the energized end of an acceptable insulator string, a bucket or worker should be positioned so that no more than ____% of the insulator string is shorted out by the buckets, worker's body, or tools.

10

15. An aerial device used for bare hand work will have a _____ contamination meter circuit built where a meter can provide continuous monitoring for leakage.

boom

16. Hot-line tools are designed to insulate personnel from energized lines and equipment. True or False

True

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17. In general, a hot stick should be cleaned _____.

both before and after use

18. Which of the following are typically done in a tailgate session?

All answers listed here are correct

19. The distance that must be kept between personnel and energized lines and equipment is referred to as the safe working distance or _____ (two words).

minimum clearance

20. The working load limitation of a hot stick _____.

is the maximum weight that the stick can safely support

21. When a tie wire is being unwound, it should be [a] from time to time to prevent it from coming in contact with the pole.

cut

22. The lift method of moving a conductor requires [a] wire tong(s), while the side method requires [b] wire tong(s).

a. one
b. two

23. Which of the following is not a tool used to move distribution lines with an auxiliary arm?

Crossarm brace

24. A conductor is locked into place on a wire holder by a _____ (two words) that engages when the conductor is lowered into position.

safety latch

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Stringing Line Conductors Module

Assignment: Read chapter 12, pages 21.1-21.15 in The Lineman's and Cableman's Handbook

PowerPoint: None

Quiz: Stringing Line Conductors

1. The tensioner, often called a [a] _____ tensioner, and the [b] _____ puller should be set up as near to midspan as possible.

ab. bull-wheel

2. Pilot lines can be installed for distribution-line tension stringing by using the _____ system.

spider

3. Why must the surface of high-voltage transmission-line conductors be protected from scratches while they are being installed?

Because conductors will have corona losses and generate radio-interference voltages that will be transmitted through the atmosphere.

4. Why is it necessary to effectively ground conductors while they are being installed?

To protect the workmen.

5. Define tension stringing

The process of installing overhead transmission or distribution line conductors in a manner that keeps the conductors off the ground, clear of other structures or traffic that might damage the conductors, and clear of energized circuits.

6. Describe the procedures to be followed to reconductor distribution lines.

Tension stringing procedures

7. What are the stringing blocks called? [a] (One word)

Travelers

8. When a linemen installs the stringing blocks on the insulators, they normally place a lightweight rope called a [a]_____ over the traveler.

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finger-line

9. When the required length of wire for installation job is being determined, a general rule is to add 10 percent to the calculated total span length to allow for jumpers, sagging and installation requirements.

True

10. Placing a uniform tension on a conductor during installation is called _____.

?

11. Where structures are uniformly spaced in a transmission circuit [a] span may be used for sagging purposes. If span lengths vary, [b] span must be determined.

a. an average
b. a ruling

12. _____are hung at the bottom of each insulator string and are used to support the wire during the stringing process.

Rollers

13. Many roller assemblies are equipped with a _____ (two words) to bleed off electrical charges that may build up during the stringing process.

grounding device

14. Which is NOT considered one of the three pulls in a typical stringing process?

Roller

15. A primary consideration for any pulling process is making sure that the wire or line is kept in the groove of the _____.

roller

16. A _____ is used to connect two lines together and to keep the lines from becoming twisted.

swivel

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17. A device mounted on the bull wheel puller to keep the bull line evenly spaced on the drum is called a _____ (two words).

level wind

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Sagging Line Conductors Module

Assignment: Read Chapter 22, pages 22.1-22.28 in the Lineman's and Cableman's Handbook.

PowerPoint: None

Quiz: Sagging Line Conductors

1. When should conductors be sagged?

Sagging operations begin as soon as the conductor string is complete, to establish the proper conductor tension for the conditions at the time the work is performed.

2. Tension in the conductor can be measured using a _____ or determined by timing mechanical waves induced by the conductor.

dynamometer

3. Ruling span (feet) =

[average span (feet)] + longest span (feet) - average span (feet)]

4. The conductor sag in any span may be determined by the expression: Span sag (inches) = [span (feet) /ruling span (feet)] ^{2} X [ruling span sag (inches)]

True

5. The clamping device for steel, aluminum, or wood-pole structures permits adjustments from) to ____inches.

2

6. A simple and accurate method of measuring the sag is by use of _____ placed on the poles below the crossarm.

targets

7. Describe how a lineman can use a transit to complete sagging operations.

A linemen stationed on one pole and looking to the corresponding pole a span length away cannot include the lowest point of the conductor in his line of sight. A transit is securely fastened to the pole at a distance equal to the desired sag below the conductor support. To observe the sag, the transit is sighted at the conductor at midspan and then is swung around until in line with the pole a span length away.

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8. The sag of the conductor can be determined by timing the wave returns with a standard stopwatch and converting the time measured to sag from the equation: Where D is in inches, t is time in seconds, and n is the number of _____(two words) counted Sad $D = 48.3 (t / 2n)^2$

return waves

9. The time in seconds required for the wave to return to the nearest support corresponds to a definite _____ that can be calculated or read from prepared tables or graphs.

sag

10. The time in seconds required for the wave to return to the nearest support is dependent of the span length or the size of the conductor.

False

11. The sagging method is most satisfactory if the line is not in motion.

True

12. How is a Unisagwatch used?

It provides direct readings of sags up to 100 ft

13. What is this and what is it used for?

Dynamometer. It is used to measure the sag when conductors are strung with unusually small sags.

14. In straight-line work, the best practice is to use a top-groove or _____ insulator.

saddle-back

15. Why are armor rods installed on some line conductors at the point of support?

Reinforcement

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16. Why are spacers installed on bundled-conductor transmission lines.

To maintain uniform distance

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APPA Safety Manual - Section 507 Module

Assignments: Read Section 503.10 Cranes, Derricks, Hoisting Equipment, 503.11 Rigging Equipment, 503.12 Aerial Devices

Power Point: Section 507 - Overhead Distribution and Transmission**,** APPA Safety Manual

Quiz: APPA Safety Manual Section 507

1. Only qualified employees and trainees, working under direct supervision, may work in areas containing unguarded, uninsulated energized lines or parts of equipment operating at [a] volts or more

50

2. When working on capacitors, the terminal shall not be short-circuited until the capacitors have been de-energized for at least [a] minutes.

five

3. All previously energized conductors shall be considered energized until tested and properly [a].

grounded

4. What is the definition of "minimum approach distance" ?

The closest distance an employee is permitted to approach an energized or grounded object.

5. Describe what they call either a Tailboard Safety Talk or Tailgate Job Briefing.

A short, formal discussion of the work to be accomplished and the safety measures to be incorporated. Normally conducted by a foreman or supervisor.

6. Rubber gloves shall be worn when using an approved switch stick or live-line tools for opening, closing, removing, or replacing hot clamps, fuses or fuse doors on cutouts.

True

7. The body of a hydraulic truck must be bonded to an effective ground because it is considered energized equipment.

True

8. When proper clearances cannot be maintained during inclement weather, rubber gloves shall be worn when making or breaking a circuit (such as switching and grounding procedures).

True

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9. Bare-wire communication conductors or structure are not considered energized lines.

False

10. Grounding - Equal potential grounding is the preferred method of grounding whenever possible.

True

11. When Equipotential grounding is not possible, dual point grounding (bracket grounding) is acceptable.

True. Note: This may change in the future

12. What is a grounding electrode?

A conductor embedded in the earth, used for maintaining ground potential or conductors connected to it and for dissipating into the earth current conducted to it.

13. When using a grounding electrode, such electrodes shall have a resistance to ground low enough to permit prompt operation of protective devices.

True

14. When attaching a ground to a line or to equipment, the ground-end connection shall be attached first, and then the other end shall be attached by using a live-line tool.

True

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Transformer Turns Ratio Testing Module

Assignment: None

PowerPoint: None

Quiz: Transformer Turns Ratio Testing

1. When a power transformer is tested using a turns ratio test set, an AC test voltage is applied to _____.

the low voltage windings in the power transformer and the reference transformer

2. The [a] on a turns ratio test set indicates the generator output voltage that is applied to the low voltage windings of the power transformer and the reference transformer.

a. voltmeter

3. Safety precautions that should be observed when a turns a ratio test is performed on a power transformer include: _____.

making sure the transformer is de-energized

4. The [a] on a test set consists of two conductors used to apply voltage from the generator across the low voltage winding of the power transformer and two other conductors used to apply the generated voltage across the low voltage winding of the reference transformer.

exciting leads

5. To determine the turns ratio of a power transformer, the turns ratio of the reference transformer is adjusted until the null meter indicates maximum current flow.

False

6. A transformer's turns ratio is the ratio of _____.

the number of turns in its primary winding to the number of turns in its secondary winding.

7. If the test leads between a turns ratio test set and the power transformer under test are properly connected, and the test set dials are set at 01.000, the null detector needle should deflect to the [a] when the generator is cranked.

a. left

8. On a turns ratio set, the [a] (two words) indicates the magnitude and direction of the current that results from voltage induced in the high voltage windings of the power transformer and the reference transformer.

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null detector

9. How is the expected turns ratio of a transformer determined?

The high voltage winding rating on the transformer's nameplate is divided by the low voltage winding rating.

10. If the actual turns ratio for a transformer is not exactly the same as the expected turns ratio, the transformer must not be put back in service.

False

11. If the current meter on a test set indicates normal current and the voltmeter indicates normal voltage, but the null meter shows no deflection regardless of the ratio selected, the problem is most likely [a] circuit in the windings being tested.

a short

12. The turns ratio of a transformer can change because of _____.

short circuits and defective tap changer parts

13. What is the purpose of transformer turns ratio testing?

Transformer turns ratio testing is performed to determine if a transformer is providing the desired ratio of primary to secondary voltage.

14. On a transformer's connection diagram, the lines on the symbols that are [a] to each other represent windings that are of the same phase.

a. parallel

15. On a transformer nameplate, the _____ diagram provides information that can be used to determine the locations of specific terminals on the transformer.

bushing layout

16. Which of the following basic principles does NOT apply to making test connections for a turns ratio test on most substation power transformers? Connecting the _____.

exciting leads to the terminal of one winding of the higher voltage transformer winding

17. As a general rule, the grounds are removed from a transformer just before the turns ratio test is performed.

True

18. What is balancing?

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Balancing is adjusting the turns ratio of the reference transformer in the turns ratio test set until it balances with, or is the same as, the turns ratio of the power transformer.

19. If the sequence of dial numbers on a turns ratio test set is 7.470, then the turns ratio for the windings of the power transformer being tested is _____.

7.470:1

20. The [a] _____ (three words) of the reference transformer in a turns ratio test set is tapped so that the turns ratio of the reference transformer can be adjusted.

a. high voltage winding

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Linemen 2420 Final Module

Assignment: Complete Final Exam

PowerPoint: None

Exam: Final

1. The tensioner, often called a [a] _____ tensioner, and the [b] _____ puller should be set up as near to midspan as possible.

a. bull-wheel
b. bull-wheel

2. Pilot lines can be installed for distribution-line tension stringing by using the _____ system.

spider

3. Define tension stringing.

The process of installing overhead transmission - or distribution-line conductors in a manner which keeps the conductors off the ground, clear of vehicular traffic and other structures that might damage the conductors, and clear of energized circuits.

4. What are the stringing blocks called? [a] (One word)

Travelers

5. When should conductors be sagged?

Sagging operations begin as soon as the conductor string is complete, to establish the proper conductor tension for the conditions at the time the work is performed.

6. Tension in the conductor can be measured using a _____ or determined by timing mechanical waves induced by the conductor.

dynamometer

7. A simple and accurate method of measuring the sag is by use of _____ placed on the poles below the crossarm.

targets

8. In straight-line work, the best practice is to use a top-groove or _____ insulator.

saddle-back

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9. The automatic reclosing feature of circuit interrupting devices are in operation when beginning work.

False

10. Live-line, bare-hand work shall not be performed on voltages less than 69 kV.

True

11. Before using the live-line bare-hand technique on energized high voltage conductors, you must voltage limitations of the aerial lift equipment intended to be used.

True

12. It is a well-known myth that you cannot work on electrical power lines during an electrical storm, as long as you are well-insulated, you are safe.

False

13. A conductive bucket liner or other suitable conductive device will bond an insulated aerial device to the energized line or equipment.

True

14. The outriggers on the aerial truck are extended and adjusted to stabilize the truck after the boom is elevated.

False

15. The [a] on a turns ratio test set indicates the generator output voltage that is applied to the low voltage windings of the power transformer and the reference transformer.

Voltmeter

16. The [a] on a test set consists of two conductors used to apply voltage from the generator across the low voltage winding of the power transformer and two other conductors used to apply the generated voltage across the low voltage winding of the reference transformer.

exciting leads

17. A transformer's turns ratio is the ratio of _____.

the number of turns in its primary winding to the number of turns in its secondary winding.

18. On a turns ratio set, the [a] (two words) indicates the magnitude and direction of the current that results from voltage induced in the high voltage windings of the power transformer and the reference transformer.

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a. null detector

19. What is the purpose of transformer turns ratio testing?

Transformer turns ratio testing is performed to determine if a transformer is providing the desired ratio of primary to secondary voltage.

20. What is balancing?

Balancing is adjusting the turns ratio of the reference transformer in the turns ratio test set until it balances with, or is the same as, the turns ratio of the power transformer.

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LINEMEN - 2420 4B

	Instructional Summary
Course Description	Student will; Learn about Supplying Quality Power, Outdoor Lighting Systems, Revenue Metering, Transformers, Equipotential Grounding
Student Learning Outcome	Student will; Describe the Factors That Affect Voltage in a Circuit, Explain Voltage Properties in Substation Distribution, Demonstrate an Understanding of Different Outdoor Lighting Systems and Safety Procedures Required, Describe the Purpose of Meters, Understand How Alternating Current and Induction Principles Apply to Transformers, Calculate Transformer Load Checks, Describe Equipotential Grounding and Safety Compliance Guidelines
Instructional Activity	In-Class Lectures Interactive/Demo Labs Online Assignments & Assessments
Material/Equipment	Keys for Lab Access -Miller Campus Course Access -Canvas
Duration	Course Jan 13 - May 4, 2012 (13 Weeks) Total Hours of Online Student Work (Estimate): _____ Total Hours of Online Instructor Work (Estimate): _____
Notes	Point of Contact: Online- Karma Wayman x5391 Program- Ashley Sokia x5354

(For additional details see the course syllabus.)

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Class Introduction Module

Assignment: Watch video & change your email

PowerPoint: None

Quiz: Practice

1. Which course are you taking?

   Lineman 4B

2. True or False: You have downloaded your class syllabus.

   True

3. How do you change your e-mail and notification settings for your online class?

   Profile link in the top right hand corner

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Supplying Quality Power - Part 1 Module

Assignment: Read pages 602-612 in Chapter 15 of the Guidebook for Linemen and Cablemen

PowerPoint: None

Quiz: None

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Supplying Quality Power - Part 2 Module

Assignment: Read pages 602-612 in Chapter 15 of the Guidebook for Linemen and Cablemen

PowerPoint: None

Quiz: None

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Supplying Quality Power - Part 3 Module

Assignment: Read pages 612-626 in Chapter 15 of the Guidebook for Linemen and Cablemen

PowerPoint: None

Quiz: Supplying Quality Power

1. The ____ setting allows some variation from the actual desired voltage setting.

   bandwidth

2. ____ losses can add to the total line loss in a circuit.

   Transformer

3. The amount of ____ in a circuit adds to the total impedance of the circuit.

   reactance

4. ____ refers to the indirect method of keeping voltage at a proper level.

   Voltage regulation

5. ____ refers to the direct method of voltage change such as changing a transformer output with transformer taps or changing the feeder voltage with line voltage regulators.

   Voltage control

6. A utility can improve power quality on a feeder by installing ____, capacitors, and surge arrestors.

   voltage regulators

7. The ____ mode of erratic voltage refers to disturbances between the neutral and the ground.

   common

8. The ____ mode of erratic voltage refers to disturbances between phases or between the phase and the neutral.

   differential

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9. _____ insulators on sub-transmission lines have been a common source of TVI.

Pin-type

10. The probable cause of intermittent noise is _____.

loose hardware

11. To find the existence of _____ voltage, connect an AC/DC voltmeter between the neutral and remote earth.

tingle

12. _____ voltage refers to a small voltage that is noticed by people or animals while contacting certain equipment or hardware.

Tingle

13. Resonance is most likely to occur when remotely switching single-pole devices on a high-voltage distribution underground cable feeding a transformer with a _____ primary.

delta

14. _____ usually occurs when one or two phases are disconnected from the source by a fault.

Ferro resonance

15. Any deviation in the magnitude or frequency of the _____ Hz sine wave is considered a power quality disturbance.

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Outdoor Lighting Systems Module

Assignment: Read pages 741-769 in Chapter 19 of the Guidebook for Linemen and Cablemen.

PowerPoint: None

Quiz: Outdoor Lighting Systems

1. A _____ truck provides the best flexibility and safety for work on a signal head of a traffic signal pole.

bucket

2. A(n) _____ is needed to stabilize the voltage and current in a gas-discharge lamp.

ballast

3. LEDs use about _____% of the power an incandescent lamp would use.

15

4. The amount of light falling on a 1-square-foot surface 1 foot away from a 1-candela source is defined as 1 _____.

lumen

5. Light pollution can easily be eliminated using _____ lighting.

cutoff

6. A Type _____ luminaire is suited for wall mounting applications and for illuminating the perimeter of parking areas.

IV

7. Lighting along highways and freeway intersections is owned by the _____.

road authorities

8. Streetlights and streetlight circuits are installed in the secondary position on a distribution pole; they are generally mandated to be at least _____ inches above any communications or television cable.

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40

9. The capacitors used in older luminaires (before 1979) are impregnated with ____.

PCBs

10. Mercury is usually in a gaseous state because it vaporizes at ____°F.

14

11. Gas-discharge lamps need a ____ to start the initial electric arc.

high voltage

12. The inner tubes of mercury-vapor and high-pressure sodium-vapor lamps put out an intense ____ radiation.

ultraviolet

13. Incandescent lamps can fail prematurely if exposed to ____ or voltage surges.

vibration

14. The most common maintenance program adopted by lighting-system owners is the scheduling of lamp replacement and cleaning in ____ blocks.

geographic

15. ____ were one of the earliest loads for the original central-station type of electric system.

Streetlights

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Revenue Metering - Part 1 Module

Assignment: Read pages 771-790 in Chapter 20 in the Guidebook for Linemen and Cablemen.

PowerPoint: None

Quiz: Revenue Metering

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Revenue Metering - Part 2 Module

Assignment: Read pages 791-802 in chapter 20 of the Guidebook for Linemen and Cablemen.

PowerPoint: None

Quiz: Revenue Metering

1. A four-wire, three-phase service can be measured with a ____ meter.

   three-element

2. ___ metering refers to energy metering on more than a one-phase service.

   Polyphase

3. A two-wire, single-phase service consists of a ____ V leg and a neutral.

   120

4. Individual tenants can be metered relatively easily using ____ metering technology.

   smart

5. ____ metering offers a customer a lower price for energy used during nonpeak hours.

   Time-of-use

6. ____ is the amount of power used over time measured in kilowatt-hours.

   Energy

7. The ____ demand is the maximum rate of consumption by a customer during a billing period.

   peak

8. Energy consumption is the ____ used by a customer.

   volts x amperes

9. A ____ tool reduces the hazard of working with socket-based meters on an energized meter base.

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meter installer and removal

10. The VT multiplier is always equal to the _____ratio.

transformer

11. The polarity of the primary and secondary terminals of instrument transformers is normally marked with a ____.

large dot

12. A ____ transformer reduces the current to a transformer-rated meter.

current

13. A ____ transformer is used when the energy to be measured is supplied at a high voltage such as Subtransmission, primary, or high secondary voltage.

potential

14. A transformer-rated ____ meter is used where the voltage and/or current is too high or impractical for a self-contained meter.

revenue

15. An energy charge to a customer is the actual ____ used.

kilowatt-hours

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Sizing CT's for Service Module

Assignment: None

PowerPoint: None

Quiz: None

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Linemen 2420 Midterm Module

Assignment: Complete Midterm Exam

PowerPoint: None

Exam: Midterm

1. A two-wire, single-phase service consists of a ____ V leg and a neutral.

   120

2. ____ metering offers a customer a lower price for energy used during nonpeak hours.

   Time-of-use

3. ____ is the amount of power used over time measured in kilowatt-hours.

   energy

4. The ____ demand is the maximum rate of consumption by a customer during a billing period.

   peak

5. Energy consumption is the _____ used by a customer.

   volts x amperes

6. A tool reduces the hazard of working with socket-based meters on an energized meter base.

   meter installer and removal

7. The polarity of the primary and secondary terminals of instrument transformers is normally marked with a ____.

   large dot

8. A ____ transformer reduces the current to a transformer-rated meter.

   current

9. A ____ transformer is used when the energy to be measured is supplied at a high voltage such as Subtransmission, primary, or high secondary voltage.

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potential

10. An energy charge to a customer is the actual ____ used.

kilowatt-hours

11. Streetlights and streetlight circuits are installed in the secondary position on a distribution pole; they are generally mandated to be at least ____ inches above any communications or television cable.

40

12. The capacitors used in older luminaires (before 1979) are impregnated with ____.

PCBs

13. Gas-discharge lamps need a ____ to start the initial electric arc.

high voltage

14. The inner tubes of mercury-vapor and high-pressure sodium-vapor lamps put out an intense ____ radiation.

ultraviolet

15. Incandescent lamps can fail prematurely if exposed to ____ or voltage surges.

vibration

16. ____ were one of the earliest loads for the original central-station type of electric system.

Streetlights

17. The amount of ____ in a circuit adds to the total impedance of the circuit.

Reactance

18. ____ refers to the indirect method of keeping voltage at a proper level.

Voltage regulation

19. _____losses can add to the total line loss in a circuit.

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Transformer

20. ____ refers to the direct method of voltage change such as changing a transformer output with transformer taps or changing the feeder voltage with line voltage regulators.

Voltage control

21. A utility can improve power quality on a feeder by installing ____, capacitors, and surge arrestors.

voltage regulators

22. The probable cause of intermittent noise is ____.

loose hardware

23. Resonance is most likely to occur when remotely switching single-pole devices on a high-voltage distribution underground cable feeding a transformer with a ____ primary.

delta

24. A(n) ____ is needed to stabilize the voltage and current in a gas-discharge lamp.

ballast

25. LEDs use about ____% of the power an incandescent lamp would use.

15

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Transformers - Part 1 Module

Assignment: None

PowerPoint: None

Quiz: None

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Rigging in Powerline Work Module

Assignment:

PowerPoint:

Quiz: Rigging in Powerline Work

1. ____ are preferred for distribution work such as lifting transformers and regulators because they are more resistant to cutting and abrasion than fiber rope and are easier to work with than wire rope or chains.

Web slings

2. A ____ has become the hoist of choice, as well as the hoist that is most abused.

web hoist

3. Chain hoists are constructed with the ____ being the weakest part.

lower hook

4. One adage to ease remembering when installing the U bolts is: "____."

never saddle a dead horse

5. The ____ splice is probably the only splice still seen in line work.

eye

6. A(n) ____ hitch is a friction hitch used to tie on to another rope to prevent it from moving or running.

taut-line

7. A ____ is a knot that can be used to make a lasso or noose, but because it stays in position, it is also useful for jobs such as tying a rope to a pole when rope guying.

running bowline

8. ____ load limit identifies the capacity of individual rigging components.

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Working

9. ____ sag refers to the sag under ice loading, wind, and temperature.

Maximum

10. A ____ represents the behavior of all the spans in the line section, and using it determines which sag data to use.

ruling span

11. A line ____ must be known to confirm the proper framing for the structure, and be capable of calculating the bisect tension involved in handling a conductor.

angle

12. A ____ hitch is the weakest form of a hitch.

single-wrap choker

13. A ____ is a hoisting device that is also used by many utilities as a pole-top/tower-top rescue device.

hand line

14. One of the more important skills when doing transmission line work is the use of proper ____.

rigging

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Transformers - Part 1 Module

Assignment: None

Power Point: None

Quiz: None

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Transformers - Part 2 Module

Assignment: None

Power Point: None

Quiz: Transformers

1. What is the most common distribution transformer that is used in residential areas?

Two bushing, single-phase
120/240 volt transformer
Two bushing, single-phase, 120/240 volt transformer. (pg. 121)

2. What are some disadvantages of wiring a second transformer identically in parallel with an existing overloaded transformer to supply single-phase service for the long term?

One disadvantage of this configuration is that two smaller transformers have more losses than one larger replacement transformer. Another disadvantage is if one transformer fails the remaining transformer could be overloaded and burn out. (pg. 123)

3. When mounting a second transformer on a pole, how many degrees apart and how many inches above or below should it be from the first one?

A second transformer should be mounted 135 degrees around the pole and 4 inches below the original transformer. (pg. 126)

4. Why are transformer load checks performed?

Transformer load tests are performed to determine when transformers are overloaded. They are also used when adding new loads, customers, etc., to a transformer. (pg. 134)

5. What is the formula for calculating the total load on a transformer?

Load in kVA = [sum of phase currents x voltage (line to neutral)] / 1,000
(pg. 136)

6. Why is it best to measure the load on each winding separately before combining winding loads to determine the total load?

It is best to check winding loads separately because although a transformer may record a safe total load it may be unbalanced with one winding seriously overloaded.

7. List at least three things to check on a transformer when looking for signs of overheating.

a. bulged tank, discolored paint, smell of burnt oil

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b. bulged tank, discolored paint, smell of burnt oil

c. bulged, discolored, burnt oil Pg 144

8. List at least three things you should check for when inspecting the primary, secondary and ground leads at a transformer installation.

a. proper connections, proper clearance, wire size, size of damage

b. proper connections, proper clearance, wire size, signs of damage

c. proper connections, proper clearance, wire size, signs of damage

9. Why is it unsafe to energize a transformer from a pole? List at least three safe options for energizing a transformer.

It is unsafe to energize a transformer from the pole because an unknown fault can occur which can cause a violent explosion and cause injury. You can safely energize from a remote device, such as an upstream disconnect switch. You can close the transformer's disconnect using a P2 fusing stick or grip-all from a safely positioned, aerial lift bucket at least 10 horizontal feet from the transformer being energized. You can use a telescopic hot stick equipped with a P2 attachment from a safe position on the ground. (pg. 144)

10. Why is it difficult to close a disconnect with a telescoping hot stick?

It tends to wobble when extended pg. 145

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APPA Safety Manual - Equipotential Grounding Module

Assignment: None

PowerPoint: None

Quiz: APPA Safety

1. What should you always check before stringing parallel to an existing energized transmission line.

Check for dangerous voltage buildups and follow the provisions in 507.13 b-j to ensure proper grounding

2. Bare-wire communication conductors or structure are not considered energized lines

False

3. What is a grounding electrode?

A conductor embedded in the earth, used for maintaining ground potential or conductors connected to it and for dissipating into the earth current conducted to it.

4. A positive rule requiring compliance by all employees concerned.

Deviation from safety rules is not permitted and is subject to disciplinary action (Page16).

5. What is the definition of "minimum approach distance."

The closest distance an employee is permitted to approach an energized or grounded object. (Page 13)

6. What is secondary voltage?

Any electrical circuit that normally operates at less than 600 volts. (Page 17)

7. All previously energized conductors shall be considered energized until tested and properly [a]. (Section 507.13 a, Pg. 158)

grounded

8. Rubber gloves shall be worn when using an approved switch stick or live line tools for opening, closing, removing, or replacing hot clamps, fuses or fuse doors on cutouts.

True

9. The automatic reclosing feature of circuit interrupting devices shall be made inoperative before live-line work begins.

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True

10. When working on capacitors, the terminals shall not be short-circuited until the capacitors have been de-energized for at least [a] minutes.

five
Section 507.10 a Page 154

11. When work is performed in the vicinity of exposed, energized parts of equipment or lines, employees shall remove all exposed conductive articles, such as keys, watches, and rings.

True

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Lineman 2420 Final Module

Assignment: Complete Final Exam

PowerPoint: None

Exam: Final

1. A ____ has become the hoist of choice, as well as the hoist that is most abused.

web hoist

2. One adage to ease remembering when installing the U bolts is: "____."

Never saddle a dead horse

3. A(n) ____ hitch is a friction hitch used to tie on to another rope to prevent it from moving or running.

taut-line

4. A ____ represents the behavior of all the spans in the line section, and using it determines which sag data to use.

ruling span

5. One of the more important skills when doing transmission line work is the use of proper ____.

rigging

6. The winding on the input side of the transformer is called the _____ winding.

Primary

7. The winding on the output side of the transformer is called the _____ winding.

Secondary

8. Transformers between the generation station and local distribution primary circuits are called _____ transformers?

Power

9. Transformers along the distribution primary circuits and the customer's property are called _____transformers?

Distribution

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10. Why is voltage stepped up, before transmitting it over long distances?

Stepping up the voltage allows the utility to transmit a given amount of power with a lower current. This allows use of smaller conductors and also reduces power losses (line losses). (pg. 30)

11. What is the percent efficiency of a transformer if 6,500 watts are input, and 6,350 watts are output?

% efficiency = (watts output / watts input) x 100 = (6,350 / 6500) x 100 = 98%. (pg. 31)

12. What should you always check before stringing parallel to an existing energized transmission line.

Check for dangerous voltage buildups and follow the provisions in 507.13 b-j to ensure proper grounding

13. Grounding - Equal potential grounding is the preferred method of grounding whenever possible.

True

14. Dual point grounding is not the same as bracket grounding.

False

15. What is a grounding electrode?

A conductor embedded in the earth, used for maintaining ground potential or conductors connected to it and for dissipating into the earth current conducted to it.

16. Two employees do not need to be present when performing routine switching of circuits (if it can be done safely).

True

17. What is the definition of "minimum approach distance."

The closest distance an employee is permitted to approach an energized or grounded object. (Page 13)

18. Before entering a confined or enclosed space, all levels of the space shall be tested for the lack of oxygen, and then for the presences of flammable or [a] (two words) and [b]. Monitoring instrumentation must be calibrated. (see Section 2 201. e)

a. toxic gases
b. vapors

19. Rubber gloves shall be worn when working on or near series street lightening circuits even though they are disconnected from the source of power.

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True

20. Movement of vehicles, gin poles, cranes, and other hoisting or mechanized equipment, shall be controlled by a signal man or a flag man in a substation.

True

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