Regional Center for Advanced Manufacturing (RCAM)

Industrial Maintenance Training
(Workforce Solutions for your Industry)

Northeast State Community College

Revised 12/2/2013

RCAM - Industrial Maintenance Courses	Hours	Discipline
Mechanical - M		
Mechanical Fasteners, Gaskets, Packing, and Flange Assembly	16	M
Threaded Piping Systems	20	M
Hose & Tubing	20	M
Steam Systems	8	M
Metallic Materials	4	M
Mechanics & Rigging	8	M
Blueprint Reading and Sketching	4	M
Precision Measuring	12	M
Shaft Couplings	4	M
Belts & Pulleys; Chains & Sprockets	12	M
Industrial Hydraulic Power	12	M
Thermal Cutting Processes	16	M
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Fundamentals of Problem Solving & Troubleshooting - Mechanical	24	M
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Mechanical

Mechanical Fasteners, Gaskets, Packing and Flange Assembly NSCC100A8B8

Lab Performance Objectives:

The following is a list of performance objectives for the Mechanical Fasteners, Gaskets, Packing and Flange Assembly Lab.

- Identify common types of fastening device.
- Select the correct type and size of fastening device for a specific task.
- Install an internal retainer ring so that it is fully engaged in the groove in a shaft.
- Install an external retainer ring so that it is fully engaged in the groove in a shaft.
- Layout and drill holes in Bracket Plate DB01 so that all dimensions are +/- 1/8" when measured with a 12" rule.
- Correctly tap holes to install bolts.
- Drill holes and install anchors in concrete.
- Identify different types of ring gaskets used in flanged connections.
- Given a copy of the *"Safe Work Process"*, discuss the correct procedure for opening a service line.
- Given a gasket cutter and different types of material, cut two or three flat ring gaskets.
- Given a gasket cutter and hole punch, cut a full-face gasket to fit a flange.
- Given a gate valve, correctly cut a bonnet gasket.
- Identify different types of packing used in industry
- Given a pump or Packing Demonstrator, remove the old packing.
- Given a pump or Packing Demonstrator, correctly clean the stuffing box, gland follower, and shaft.
- Given a pump or Packing Demonstrator, measure the stuffing box to determine the correct size and number of packing rings to use.
- Given a packing cutter, packing, pump or Packing Demonstrator, correctly cut the packing and install it in the pump.
- Given a pump or Packing Demonstrator and proper tools, correctly adjust the packing using the correct tightening sequence.
- Given a gate valve and packing, remove the old packing, clean the stuffing box, select the correct packing and install it in the valve.
- Given a Piping & Instrumentation Diagram (P & ID drawing) be able to locate Line Classification Numbers for a particular process system.
- Using a Line Classification Number be able to explain what each element of the Number represents.
- Identify the Piping Specification Number included in the Line Classification Number.
- Locate a Piping Specification by using Engineering Standards.
- Using the Piping Line Classes Standard identify the piping standard for a particular material group.
- Using a Piping Specification determine the materials needed for flange assembly.
- Identify flange assembly types.
- Using a *Piping Specification* Standard, determine the materials needed for flange assembly.
- Correctly disassemble a flanged pipe connection.
- Correctly assemble a flanged pipe connection following the Bolt Torque Procedure.

Lab Hours: 16

Threaded Piping Systems
NSCC1005508

Lab Performance Objectives:

The following is a list of performance objectives for the Threaded Piping Systems Lab.

- The student will be able to identify each and describe the following:
  - black iron, stainless, galvanized pipe
  - 45 and 90 degree elbows
  - tees and crosses
  - reducers and bushings
  - caps and plugs
  - flanged joints
- Determine the correct thread engagement for different fittings.
- Identify the material, schedule, and size of a pipe by measuring and using tables in the reference materials provided.
- Safely and successfully assemble pipe nipples and pipe fittings.
- Demonstrate the ability to tape the pipe correctly.
- Safely and correctly use pipe wrenches to assemble the pipe and fittings.
- Explain the use of ***Engineering Standard 15480.G150*.** Explain that this standard will not be used in this class due to lack of ventilation.

  Note: Use of zinc to coat exposed threads requires approval of division supervision and the Safety Department prior to use. Use of zinc could have been hazardous when used in aerosol form over a period of time. The use of a filter is recommended in enclosed areas.
- Safely and correctly cut, ream, and thread pipe using the following tools:
  - hand pipe cutter
  - hand pipe reamer
  - hand threader (ratchet threader) and dies
  - assorted sizes of pipe wrenches
  - pipe vises
- Safely and correctly cut, ream and thread pipe using the following power shop equipment:
  - shop band saw
  - shop pipe machine (with cutter, reamer, oil feed, and thread dies)
- Demonstrate the ability to cut pipe to the correct length following all safety regulations and practices.
- Demonstrate the ability to safely and correctly thread the pipe using the pipe machine and hand tools.
- Safely and correctly use pipe wrenches to assemble the pipe and fittings(Using threaded pipe, pipefitting, and pipe vises).
- Safely assemble and disassemble a flanged joint(using combination wrenches).
- Given a figure panel containing different piping sketches and the piping jigs in Mechanical Lab 123, assemble the piping systems represented in the sketches using the Frankland ***"THE PIPE FITTER'S AND PIPE WELDER'S HANDBOOK"***, Anvil's "***Pipe Fitters Handbook"***, and Reference Panel 1 and 2.
- On completing the assigned exercises, the student will have a working knowledge of assembling the following:
  - straight runs of pipe
  - pipe runs with 90 degree turns
  - pipe runs with 45 degree offsets
  - pipe runs with 45 degree rolling offsets
  - installing valves and unions in threaded systems

    - pipe runs with flanged joints
- On completing the different exercises given by the instructor, the student will be able to make a piping sketch with the correct dimensions and symbols.
- Upon completion of this module, the student will have an understanding of Engineering Standard 15480.1000 relating to piping supports as listed in the Reference Panels.

Lab Hours: 20

Hose & Tubing
NSCC1003D21

Lab Performance Objectives:

The following is a list of performance objectives for the Hose & Tubing Lab.

- Given a section of rubber hose, a shoe knife, and a rule, measure and cut the hose to a specified length with a tolerance of ± 1/8 inch.
- Given a section of hose and access to a belt sander, square the ends of the hose to a tolerance of ± 1/16 inch.
- Given a section of hose and a barbed type Hansen quick disconnect coupling, install the fittings in the hose ends so that the ends of the hose are flush with the fitting flange or stop. Allow no more than a 1/16 inch gap at any one point for the hose being out of square.
- Given a T301 Band-It Tool, preformed center punch type clamps, and a section of hose with fittings installed, clamp the hose to the fittings following manufactures instructions.
- Given a section of Type L copper tubing, tubing fittings, and steel wool or emery cloth, prepare tubing and fittings to be soldered.
- Given a propane torch, a bottle of propane gas, a striker, leather gloves, and safety glasses, assemble and light the torch in a safe and correct manner.
- Given properly prepared tubing and fittings, and a propane torch, assemble and solder the joints.
- Given a section of copper and stainless tubing, a tubing bender, and a rule bend the tubing at various angles so as to have the bends at a specified distance from the end of the tubing or the center of another bend to a tolerance of ± 1/8 inch.
- Given a section of copper tubing, compression and flare type connectors, drawings, and access to the proper tools and equipment, fabricate and install the tubing in a practice frame to a tolerance of ± 1/8 inch.

Lab Hours: 20

Steam Systems
NSCC1003D27

Lab Performance Objectives:

The following is a list of performance objectives for the Steam Systems Lab.

- Assist in starting the Amatrol Steam System and produce steam at a sufficient pressure to complete the study of Steam Traps.
- Be mindful of the hazards associated with working with Steam and Steam Systems components. (Safety Reviews)
- Use an Infrared Pyrometer, Stethoscope and Ultrasonic Sound Detector to verify the proper operation of various Steam Traps.
- Use the above mentioned equipment to determine improper operating Steam Traps.
- Review the installation and operation of Contro Tracing on process piping.
- Successfully blowdown the Amatrol Steam System and secure the test stand.

Lab Hours: 8

Metallic Materials
NSCC1003D24

Lab Performance Objectives:

The following is a list of performance objectives for the Metallic Materials Lab.

- Given various samples of metals, the student will be able to identify each by use of a Color Code Chart and by their physical structure.
- Given samples of selected metals and the appropriate tools, the student(s) will be able to saw, file, drill, and tap these metals while demonstrating proper safety methods.

Lab Hours: 4

Mechanics & Rigging
NSCC1003D1E

Lab Performance Objectives:

The following is a list of performance objectives for the Mechanics & Rigging Lab.

- Fabricate a sling and assemble thimble eyes on each end of a 1/4" wire rope, correctly installing 1/4" U-Bolt clips according to JTS Basic Rigging Training Manual.
- Correctly tie a Square knot, two Half Hitches, Bowline knot, Timber Hitch, Sheet Bend, and Clove Hitch according to JTS Basic Rigging Training Manual.
- Install a beam clamp correctly, following the basic rules in the JTS Basic Rigging Training Manual.

- Perform a chain hoist safety inspection, following the basic rules in the JTS Basic Rigging Training Manual.
- Install a half ton chain hoist safely, following guidelines in the JTS Basic Rigging Training Manual.
- Use a permanent structure to safely install a lever hoist, and to lift a Load H-Beam.
- Use a Gantry Crane, Chain Hoist, and Lever-Operated Hoist to lift and pull a pump horizontally.
- Use Mighty Movers to move a pump across the floor.
- Select the correct sling and use it safely for a drifting job.
- Using a Gantry Crane, drift a pump using rigging accessories such as; shackles, slings, beam clamps, and chain hoists.
- Demonstrate Rigging Hand Signals and Verbal Commands
- Using an Air Hoist, lift a section of pipe.

Lab Hours: 8

Blueprint Reading and Sketching
NSCC1005522

Lab Performance Objectives:

The following is a list of performance objectives for the Blueprint Reading and Sketching Lab.

- Given a blueprint, the student will be able to:
  - Locate, identify, and interpret the title, bill of material, and revision blocks.
  - Locate and identify critical information about the object such as location of various parts of the overall project, floor elevations, and associated drawings with related information.
- Given an assortment of various shapes of wooden blocks, sketch pad and pencil; sketch the objects in orthographic format.
- Successful completion of this course will enable the student to:
  - Read and interpret simple prints.
  - Read and interpret plan and elevation prints.
  - Read and interpret equipment layout prints.
  - Read and interpret prints of machine parts.
  - Identify different areas on a print.
  - Make a 3-view sketch of an object.
  - Dimension sketches.

Lab Hours: 4

Precision Measuring
NSCC1003D41

Lab Performance Objectives:

The following is a list of performance objectives for the Precision Measuring Lab.

- Given an outside vernier micrometer, accurately measure outside diameters of machine parts to a tolerance of +/- .0001".
- Given a depth micrometer, accurately measure depths of machine parts bores to a tolerance of +/- .001".
- Given an optical flat, measure the flatness of a mechanical seal.
- Given a machinist level and a surface plate, level a machine part with the aid of shims.
- Given a dial caliper, accurately measure outside and inside dimensions of machine parts to a tolerance of +/- .001".
- Given a dial indicator, check run out, end play and deflection of a shaft.
- Given a telescoping gauge, accurately measure various inside diameters and record the measurement with the aid of an outside micrometer.
- Given a feeler gauge, accurately measure the clearances of various items.
- Given an inside micrometer, accurately measure inside dimensions of machine parts to a tolerance of +/- .001".
- Given a shaft to measure, select the appropriate precision tools addressed in Module One and Two, and accurately measure the shaft to a tolerance of +/- .001".

Lab Hours: 12

Shaft Couplings
NSCC1003D95

Lab Performance Objectives:

The following is a list of performance objectives for Shaft Couplings Lab.

- Identify the following types of couplings:
  - Flexible Sleeve Coupling – (Woods)
  - Flange Coupling
  - Elastomer Spacer Coupling – (Omega 4) and Falk R31
  - Gear Coupling
  - Flexible Disc Coupling – (Thomas)
  - Grid Coupling – (Falk)
  - Chain Coupling
- Install the following types of couplings:
  - Woods Sure-Flex #5 SC 'Dropout' Coupling
  - Steelflex 'Dropout' Grid Coupling T31
  - Rexnord Omega 4 Elastomer Coupling
  - Falk R31 Elastomer Spacer Coupling
  - Thomas Flexible Disc Coupling, size 150

Lab Hours: 4

Belts and Pulleys; Chains and Sprockets
NSCC10012B2

Lab Performance Objectives:

The following is a list of performance objectives for Belts and Pulleys; Chains and Sprockets Lab.

- Given an Emerson Power Transmission Catalog, and IPT Industrial Trades Training Manual, correctly identify belt drive systems and their component parts.
- Given a specified set of sheaves and dimensions, correctly calculate the correct belt size and length.
- Using the Lab-Volt Mechanical Trainer, correctly install sheaves and belt(s) in accordance to ANSI recommended specifications.
- Using the Lab-Volt Mechanical Trainer, correctly align the drive members of a belt drive system.
- Using the Lab-Volt Mechanical Trainer with sheaves and belt installed, and a belt tensioning tool, correctly set the belt tension to within manufacturer's specifications.
- Given an Emerson Power Transmission Catalog, an IPT Industrial Trades Training Manual, correctly identify chain drive systems that include roller, multiple-strand and silent chain.
- Given a specified set of sprockets and dimensions, correctly calculate the correct chain size and length.
- Identify the component parts of a chain drive system that includes sprockets and hubs.
- Using the Lab-Volt Mechanical Trainer and chain and sprockets, correctly install and align the drive members of a chain drive system.
- Given a selection of sample chain, examine the various chains and determine the types.
- Using the Lab-Volt Mechanical Trainer, a set of chain sprockets and roller chain, correctly set the chain sag to within 2-3% of the shaft's center to center dimension.

Lab Hours: 12

Industrial Hydraulic Power
NSCC10045D8

Lab Performance Objectives:

The following is a list of performance objectives for Industrial Hydraulic Power Lab.

- To become familiar with the Lab-Volts Hydraulics Trainer. To identify the various system components and to be aware of the safety rules to follow when using the Trainer.
- Investigate a hydraulic circuit and to raise a load using a small hydraulic cylinder.
- Introduce the operation of a relief valve.
- Establish the oil flow path in a circuit using a pressure relief valve.
- Connect and operate a circuit using a pressure relief valve.
- Verify the formula F = P x A using a cylinder and a load spring.
- Discover what happens to a cylinder when equal pressure is applied to each side of its piston.
- Explain the concept of pressure distribution in a cylinder in equilibrium of forces.
- Describe the operation of a flow control valve.
- Establish the relationship between flow rate and velocity.

- Operate meter-in, meter-out, and bypass flow control circuits.
- Define the terms “work” and “power”.
- Establish the relationship between work, force, and power.
- Calculate the work, power and efficiency of a hydraulic system.
- Learn how to control the direction, force, and speed of a cylinder;
- Introduce the operation of a directional control valve;
- Describe the effect a change in system pressure or flow rate has on the speed of a cylinder;
- Describe the effect of a change in system pressure or flow rate has on the force exerted by a cylinder.
- Describe the design and operation of a hydraulic motor;
- Calculate the torque and speed of a hydraulic motor;
- Determine the effect a change in flow rate or pressure has on motor operation.
- Describe the basic operation of a hydraulic pump;
- Use manufacturer pump specifications to test a pump in a hydraulic system.
- To explain how oil temperature affects flow rate and volumetric efficiency.

Lab Hours: 12

Thermal Cutting Processes
NSCC1009007

Lab Performance Objectives:

The following is a list of performance objectives for Thermal Cutting Processes Lab.

- Safely perform thermal cutting operations in a maintenance environment.
- Assemble, operate and disassemble Oxy-fuel cutting equipment.
- Assemble, operate and disassemble Air Carbon Arc cutting equipment.
- Assemble, operate and disassemble Plasma Arc cutting equipment.
- Layout and cut plate and various forms of structural steel with thermal cutting equipment.
- Set-up and use straight edge guides and circle cutting guides.
- Use thermal cutting equipment to gouge metal.

Lab Hours: 16

Rotalign Laser Alignment
NSCC100143A

Lab Performance Objectives:

The following is a list of performance objectives for Rotalign Laser Alignment Lab.

Given a Rotalign Ultra Laser Alignment Unit and two machine shafts, be able to align the machine shafts to the tolerances listed in the table. The student will be able to do the following: (Use pump/motor units to deliver training.)

- Determine if the machine has a solid foundation, excessive coupling play, excessive shaft play, soft foot, or piping strain before attempting an alignment.
- Mount the laser and prism on the two machine shafts so that they are aligned with each other.
- Select the correct application in the Rotalign system for performing a horizontal machine alignment.
- Enter the correct machine dimensions for an alignment into the Rotalign Computer.
- Set the Rotalign system so that it will make alignments to the tolerances listed in the "Excellent" table.
- Adjust the laser and prism so that the laser beam is reflected into the measuring range of the position detector.
- Measure the alignment of the two machine shafts.
- Determine the foot corrections necessary for the front and back feet of the “Machine To Be Moved” (MTBM).

Lab Hours: 12

Bearings & Oil Seals Lab
NSCC10012B0

Lab Performance Objectives:

The following is a list of performance objectives for Bearings & Oil Seals Lab.

- Given a laptop, a “Bearing Manual DVD” and various types of bearings and oil seals, the student will be able to identify each.
- Given a laptop, a “Bearing Manual DVD” and an assortment of bearings, the student will be able to decode the various manufacturer symbols and cross-reference from one bearing manufacturer to another.
- Given a laptop, a “Bearing Manual DVD”, an assortment of bearings, and various measuring instruments, the student will be able to locate and cross-reference a bearing by using dimensions only.
- Given a laptop, a “Bearing Manual DVD”, seal housing, pump shaft, and various measuring instruments, the student will be able to locate and cross-reference a seal by using dimensions only.
- Given a laptop, a “Bearing Manual DVD” and various seal manufacturers’ names and seal numbers, the student will be able to locate and cross-reference the seals between different manufacturers.
- Given a laptop, a “Bearing Manual DVD” and using the Educational Section as a reference, the student will be able to select the proper tools for the removal, inspection and installation of specific bearings and oil seals.
- Given access to a hydraulic press and a pump shaft with bearings installed, the student will be able to safely and correctly remove and replace the bearings using the hydraulic press.

- Given access to an induction heater, pyrometer, bearing puller, and a pump shaft with bearings installed, the student will be able to safely and correctly pull the bearings from the shaft and replace them using the induction heater.
- Given access to a hydraulic press, bearing covers, and seal driver, the student will be able to safely and correctly remove and replace an oil seal.

Lab Hours: 12

Fundamentals of Problem Solving & Troubleshooting – Mechanical

NSCC10083D1

Lab Performance Objectives:

The following is a list of performance objective(s) for Fundamentals of Problem Solving & Troubleshooting - Mechanical.

- Conduct a valid and reliable "Troubleshooting Process", the process can then be used to isolate the malfunction in most mechanical, electrical & instrument systems.

Lab Hours: 12

Gears Lab
NSCC100456F

Lab Performance Objectives:

The following is a list of performance objectives for Gears Lab.

- Using the DAC Gear Maintenance Trainer, spur gears, the acrylic gear sample, and the IPT Industrial Trades Manual, identify:
  - common components.
  - construction features.
  - terminology.
  - concepts.
- Using the ***IPT Trades Manual***, as well as the spur gears and helical gears included with the training aid, identify terminology and features associated with parallel shaft gearing.
- Using the ***IPT Industrial Trades Manual***, a magnetic base/dial indicator set, dial calipers, shafts, and spur gears included with the training aid, install spur gears in training aid and align the spur gear to manufacturer's specification.
- Using the ***IPT Industrial Trades Manual***, and the tapered roller bearings included with the training aid:
  - Identify terminology and procedures for installing taper lock roller bearings.
- Using the ***IPT Industrial Trades Manual***, a magnetic/dial indicator set, shafts, and helical gears included with the training aid, install helical gears in training aid and align helical gears to specification.

Lab Hours: 16

Mechanical Seals Lab
NSCC10012C1

Lab Performance Objectives:

The following is a list of performance objectives for Mechanical Seals Lab.

- Explain what a mechanical seal is.
- Explain why a mechanical seal is used over compression packing.
- Explain the difference between a Single Component Seal and a Single Cartridge Seal.
- Learn how a mechanical seal works and what they look like.
- Learn what can happen between the stationary and rotary faces.
- Learn how fluid film helps between the seal faces.
- Correctly install and remove a cartridge seal using a variety of hand tools.
- Learn about Double Seals, how they work and why they're used.
- Learn about Barrier Fluids and Buffer Fluids and when they're used.
- Learn about environmental controls.
- See the common types of mechanical seals used at Eastman.

Lab Hours: 2

Centrifugal Pumps Lab
NSCC10012C3

Lab Performance Objectives:

The following is a list of performance objectives for Centrifugal Pumps Lab.

- Using Lab-Volts Pump Training System the student will be able to learn how to start-up, operate, and troubleshoot centrifugal pumps.
- Using Lab-Volts Pump Training System the student will be able to measure frequency, voltage, speed, pressure, and flow rate of centrifugal pumps.
- Given a centrifugal pump and a manufacturer "Maintenance Manual", the student will be able to correctly identify the components of the pump. .
- Given a centrifugal pump, a manufacturer "Maintenance Manual", and an assortment of measuring instruments, the student will be able to set up and check the following pump specifications:
  - Impeller clearance
  - Shaft runout
  - Shaft end play
  - Shaft deflection
- Given a centrifugal pump, a manufacturer "Maintenance Manual", and an assortment of tools, the student will be able to safely and correctly remove the power end of the pump.
- Given a centrifugal pump power end, manufacturer "Maintenance Manual", and an assortment of tools, the student will be able to safely and correctly disassemble and inspect the components.
- Given the correct components or using the existing components, a manufacturer "Maintenance Manual", and an assortment of tools, the student will be able to safely and correctly assemble the power end of a centrifugal pump.

- Given the power end of a centrifugal pump and an assortment of tools, the student will be able to safely and correctly install the power end into the case.
- Given a centrifugal pump and manufacturer "Maintenance Manual", the student will be able to review the start-up procedures for the pump.

Lab Hours: 16

Positive Displacement Pumps Lab
NSCC1004808

Lab Performance Objectives:

The following is a list of performance objectives for Positive Displacement Pumps Lab.

- Given a Pneumatic Diaphragm Pump and a Lab-Volt Work Order, the student will be able to correctly disassemble, inspect, and reassemble the pump.
- Given an External Gear Pump and a Lab-Volt Work Order, the student will be able to correctly disassemble, inspect, reassemble, operate, and troubleshoot the pump.
- Given a Piston Pump and a Lab-Volt Work Order, the student will be able to correctly lubricate, install, operate, and troubleshoot the pump.
- Given a Vane Pump and a Lab-Volt Work Order, the student will be able to identify the components, install, operate, and troubleshoot the pump.
- Given a Vickers V10 Vane Pump and a service/parts manual, the student will be able to correctly disassemble, inspect, and reassemble the pump for either left or right hand rotation.
- Given a Viking Model F432 Pump and a service/parts manual, the student will be able to correctly disassemble, inspect, and reassemble the pump.
- Given a Vickers V2010 Vane Pump and a parts manual, the student will be able to correctly disassemble, inspect, and reassemble the pump for either left or right hand rotation.

Lab Hours: 12

Welding Fundamentals Lab
NSCC1004896

Lab Performance Objectives:

The following is a list of performance objectives for Welding Fundamentals Lab.

- Set up a DC welder properly.
- Set up a DC welder for the proper current range for 1/8" E308L electrode.
- Set up the proper current range for 3/32" E7018 electrode.
- Set up the proper current range for 1/8" E7018 electrode.
- Set up a DC welder for the proper current range for 3/32" E316L electrode.
- Explain how to sharpen tungsten for welding steel
- Set up proper current range for TIG welding steel.

- Explain how to prepare tungsten correctly for welding Aluminum.
- Set a TIG welder to STRAIGHT polarity.
- Explain the difference between a wet-head and a dry-head.
- Explain how to set up TIG welder for welding Aluminum.
- Know the proper cup size for welding Aluminum.

Lab Hours: 20

Equipment Installation Lab
NSCC1003D23

Performance Objectives:

The following is a list of performance objectives for Equipment Installation Lab.

- Given a drawing of a building's Floor Plan, identify a particular location in the building.
- Using a building drawing and a set of instructions, locate the base line for setting a piece of equipment.
- Using a building drawing and a set of instructions, lay out centerlines for setting equipment to a tolerance of ± ¼".
- Using a building drawing and a set of instructions, lay out the bolt holes for setting equipment to a tolerance of ± ¼".
- Using a building drawing and a set of instructions, correctly set a piece of equipment according to the instructions.
- Using a Water Level, accurately transfer elevations to a tolerance of ± 1/8" and calculate the new elevation of a given point.
- Using a Transit, accurately transfer elevations to a tolerance of ± 1/16" and calculate the new elevation of a given point.
- Using an Automatic Level and Leveling Rod, calculate distances of given points.
- Using a Laser Distance Measure, determine distances of given points.
- Given a Water Level, set up and align bearing blocks on portable frames to a tolerance of ± 1/8".
- Given a Transit, set up and align bearing blocks on portable frames to a tolerance of ± 1/8".

Lab Hours: 12

Heat Exchanger Lab
NSCC10012C7

Lab Performance Objectives:

The following is a list of performance objectives for Columns and Heat Exchangers Lab.

- Given correct reference information and proper tools, the student will be able to select and install heat exchanger tubes.
- Using manufacturers information and given a tube expander, the student will be able to roll a 3/4" tube to the proper specifications.

- Given a collapsing tool, the student will be able to safety collapse a ¾" copper tube and remove tube.
- Given a pneumatic chipping hammer and tube drift, the student will be able to remove a stainless steel heat exchanger tube.
- Given manufacturers reference material, the student will be able to select the correct tapered plugs for stopping tube leakage.
- Using TED Vessel Site Practices handout, "Nameplates" and TED Heat Exchanger Shell/Tube Test Drawings pertaining to hydrostatic pressure testing, the student will learn how to inspect for leaking tubes in heat exchangers.

Lab Hours: 8

Instrumentation

RCAM Instrumentation Overview

NSCC1007791A

Lab Performance Objectives:

The successful manufacture of Quality products by a manufacturer is heavily dependent on the sensing and control of the many process variables which make up their production processes. This lab will give you a basic overview of how various process variables are measured, transmitted, controlled and how the individual components work together to form the "control loops" used by manufacturers to produce their products.

- Observe the flow (process variable) of product (dark green liquid) through the tubes.
- Observe the flow (manipulated variable) of cooling/heating medium (light green liquid) through the shell.
- Observe the pressure and flow from a centrifugal pump using a Speed Control on the pump motor to control flow.
  - Observe and operate three single loop measurement/control functions.
  - Level measurement and control
  - Flow measurement and comparison of two flow device
  - Pressure measurement and recording

Lab Hours: 4

Instrument Fundamentals
NSCC1007791

Lab Performance Objectives:

- Perform conversions between:
  - PSI
  - Inches H_20
  - Millimeters of Mercury
  - Inches of Hg
  - Absolute pressure
  - Gauge pressure
- Calibrate an electronic analog transmitter.
- Install the transmitter on the Water Process Simulator in a control loop and control the pressure at the desired set-point.
- Define terminology associated with level and level measurement concepts.
- Recall the instrumentation and methods used to measure level.
- Identify direct and indirect level devices.
- Measure level of tank and compare to transmitter reading.
- Observe operation of a bubbler system.
- Define the term delta P.
- List some devices that use this principle to measure flow.
- Convert delta P values into actual flow rates as the flow is varied on a process simulator, given the mathematical formulas.
- Identify the fours scales to measure temperature and be able to convert from one temperature scale to another.
- List and describe the operation of three temperature-filled systems and state how remote temperature measurement is made possible.
- Identify several types of thermocouples and determine the correct polarity of each.
- Recall how to check the condition of a thermocouple.
- Identify the parts and construction of various RTDs and thermistors, and recall how they measure temperature.
- State how resistance readings are taken from RTDs and thermistors.
- Identify thermocouples, measure their outputs, interpret their reference charts, and make jack connection.
- Identify resistance temperature detectors (RTDs), measure their outputs, and interpret their temperature conversion charts.

Lab Hours: 20

Control Valves
NSCC1001382

Lab Performance Objectives:

The following is a list of performance objectives for Control Valves Lab.

- Disassemble, inspect, and reassemble a diaphragm/cylinder actuated control valve.
- Perform maintenance on a control valve.
- Adjust a diaphragm/cylinder actuated control valve to the manufacturer's specifications.
- Mount a pneumatic valve positioner on a diaphragm/cylinder actuated control valve.
- Calibrate a pneumatic valve positioner to the manufacturer's specifications.
- Perform minor maintenance on a current to pressure (I/P) transducer.
- Verify proper operation of the transducer.
- Hook-up a current to pressure (I/P) transducer to necessary air supply and use it supply a proper signal to the positioner to stroke either a cylinder/diaphragm operated control valve.
- Identify the type of ¼ turn valve, the method of converting linear motion to rotary motion. i.e. rack and pinion, scotch yoke etc.
- Hook-up and calibrate a rotary motion positioned control valve.
- Make a determination as to the cause a rotary valve doesn't track the incoming instrument signal properly.

Lab Hours: 16

Pressure Measurement
NSCC10012D5

Lab Performance Objectives:

The following is a list of performance objectives for Pressure Measurement Lab.

This course consists of hands-on lab exercises designed to assist the student to obtain the skills and knowledge necessary to perform calibration, understand basic control fundamentals and limited troubleshooting procedures on various types of pressure measuring instruments. Common test equipment will be used to provide calibration standards.

- Given an assortment of elastic deformation pressure elements, identify diaphragm elements, pressure capsules, bellows, and bourdons.
- Given an electronic differential pressure transmitter, test equipment, a manufacturer's manual, and hand tools, calibrate the transmitter to manufacturer's specifications.
- Given the physical appearance and the data gathered during the calibration procedure for each of the measuring instruments calibrated, determine the operational condition of the instrument.
- Using the manufacturer's manual, perform an upscale and downscale calibration check on the measuring instrument listing the as-found condition on the instrument history report.
- Determine the accuracy of the measuring instrument using the as-found data/condition instrument history report.
- Given an electronic absolute pressure transmitter, test equipment, a manufacturer's manual, and hand tools, calibrate the transmitter to manufacturer's specifications.

The trainee will be introduced to the dynamics of process control systems, open-loop and closed loop processes, block diagrams and various types of processes.

- Feedback control
- On-Off control
- PID control
- Proportional controller
- Proportional and Integral controller
- Proportional, Integral and Derivative controller
- Proportional and Derivative controller
- Comparison between the P, PI and PID control
- The Proportional, Integral and Derivative action

Lab Hours: 16

Liquid Level Measurement
NSCC1001327

Lab Performance Objectives:

The following is a list of performance objectives for Liquid Level Measurement Lab.

- The student will understand Level Measurement of a Pressurized Vessel using a wet leg reference.
- The student will understand and be able to set-up differential pressure transmitters for level measurement of both closed and open vessels.
- The student will have a basic understanding of the open loop method of controller tuning.
- The open-loop Ziegler-Nichols method.

Lab Hours: 8

Fluid Flow Measurement

NSCC1001328

Lab Performance Objectives:

The following is a list of performance objectives for Fluid Flow Measurement Lab.

- This is the second in a series of four courses which reinforces the concepts of measurement, calibration and introduces the student to Controllers, Process Control, Control Loops and Fundamental Control Troubleshooting. This second course consists of hands-on lab exercises designed to assist the student to obtain the skills and knowledge necessary to perform configuration of a differential pressure transmitter to measure flow from pressures derived from an orifice plate and or venturi tube.
- Brief review of new control modes.
- Tuning with the Ziegler – Nichols ultimate-cycle method.
- Limits of the ultimate-cycle method.

Lab Hours: 8

Temperature Measurement
NSCC1001329

Lab Performance Objectives:

The following is a list of performance objectives for Temperature Measurement Lab.

- Recall the terminology associated with temperature and temperature measurement, and become familiar with the instruments used to measure temperature.
- Review identifying thermocouples, how to measure their outputs and interpret their reference charts.
- Review identifying resistance temperature detectors (RTDs), how to measure their outputs and interpret their temperature conversion charts.

- Setup and bench calibrate a smart temperature transmitter and correctly document the transmitter's specifications acquired from the transmitter's internal memory and nameplate data using both a hand-held communicator and a lap-top PC running HART protocol software.
- Perform a Guided Process Control Troubleshooting Process and apply it to a "control problem" to troubleshoot the problem to the root cause.

Lab Hours: 8

Digital Instruments
NSCC10013B6

Lab Performance Objectives:

The following is a list of performance objectives for Digital Instruments Lab.

- Upon completion of this module, the trainee should have a better understanding of both Hart and Foundation Fieldbus Protocols.
- Configure and calibrate a Rosemount 3051S Series Smart Transmitter to manufacturer's specifications (HART Protocol).
- Configure and calibrate a Rosemount 5400 Series Radar Level Transmitter to manufacturer's specifications (HART Protocol).
- Configure and calibrate a Rosemount 3100 Series Ultrasonic Level Transmitter to manufacturer's specifications (HART Protocol).
- Configure and calibrate a Rosemount 8800 Series Vortex Flow Transmitter to manufacturer's specifications (HART Protocol).
- Configure and calibrate a Rosemount 8700 Series Magnetic Flow Transmitter to manufacturer's specifications (HART Protocol).
- Configure and calibrate an Endress+Hauser Promass 83 Coriolis Transmitter to manufacturer's specifications (Foundation Fieldbus Protocol).
- Configure and calibrate an Endress+Hauser Deltabar S DP Transmitter to manufacturer's specifications. (Foundation Fieldbus Protocol).
- Configure and calibrate a Fischer "Smart" Control Valve (both Hart and Foundation Fieldbus) to manufacturer's specifications.
- Using an Allen-Bradley ControlLogix PLC establish control of a level and flow loop in the following modes of control:
    - On-Off
    - PID
    - Cascade

Lab Hours: 32

Electronic Loop Troubleshooting
NSCC10047E4

Lab Performance Objectives:

The following is a list of performance objectives for Electronic Loop Troubleshooting Lab.

- Review Series Loop Structure
- Review ISA Standard Symbols
- Review voltage, current and continuity measurement
- Review five step troubleshooting process
- Utilize a systematic approach to troubleshoot single-loop control systems to develop your troubleshooting skills via a guided troubleshooting exercise.
- Allow the trainee to experience several problem solving/ troubleshooting exercises without any guidelines**.**

Lab Hours: 16

PLC Fundamentals
NSCC1007A44

Lab Performance Objectives:

The following is a list of performance objectives for PLC Lab.

- Review PLC basics: architecture, PLC system, memory organization, types of files, program scan, programming language, RS Logix®, I/O configuration, and modes of operation.
- Revise PLC relay-type instructions and download and test a PLC ladder program that uses relay-type instructions to control the turning on and turning off of two pilot lamps.
- Revise PLC timer instructions and download and test a PLC ladder program that uses timer-on instructions to turn on three pilot lamps in a programmed order and for a definite period of time.
- Revise PLC counter instructions and download and test a PLC ladder program that used counters in cascade.
- Perform an initial communications setup for a SLC 500 using RS Logix® software with a 1743-CP3 cable using a laptop PC and the serial Com Port 1 of the PC (establishing and deleting the program multiple times).
- Download a PLC program from a flash memory card.
- Revise PLC latching and comparison instructions and download and test a PLC ladder program that uses latching and counter-driven comparison instructions.
- Connect and test a PLC-controlled hydraulic system that continuously reciprocates a cylinder and makes it dwell (wait) in two predetermined positions for some period of time.
- Connect and test a PLC-controlled hydraulic system that makes a motor rotate 200 turns and then reciprocates a cylinder five times.
- After review of "A Troubleshooting Process", the participants will be given various faults to troubleshoot and correct in the Exercise Six lab setups for the balance of the remaining time of the hands-on lab.

Lab Hours: 16

Electrical

Industrial Electricity: Basic Principles
NSCC10080B2

Lab Performance Objectives:

The following is a list of performance objectives for Industrial Electricity: Basic Principles Lab.

- List types of electricity and the two main types of electrical current.
- Identify resistor values using the resistor color code.
- Calculate power in a simple electrical circuit.
- State the direction of electron current flow.
- State which materials are good conductors.
- Identify various switches, such as a normally open pushbutton, a normally closed pushbutton, a selector switch, and a toggle switch.
- Explain a short circuit and the role of overload protection.
- Define and illustrate current and voltage relationships in Ohm's Law.
- Construct a series, a parallel circuit, and series-parallel circuit and measure voltage across, resistance of, and current in the circuit.
- Calculate unknown voltage, current, and resistance values in various series, parallel, and series-parallel Ohm's Law problems.

Lab Hours: 8

Industrial Electricity: Alternating Current
NSCC10080B3

Lab Performance Objectives:

The following is a list of performance objectives for Industrial Electricity: Alternating Current Lab.

- Describe the advantages of alternating current.
- Explain electromagnetic induction.
- Describe the components of a sine wave.
- Describe alternating current waveforms.
- Calculate effective value of a sine wave.
- Calculate average value of a sine wave.
- Define the terms, units, and symbols associated with inductance and capacitance.
- Explain inductance and capacitance and the effects of both on ac circuits.

Lab Hours: 4

Industrial Electricity: Conductors & Wiring
NSCC10080B4

Lab Performance Objectives:

The following is a list of performance objectives for Industrial Electricity: Conductors & Wiring Lab.

- Properly solder a connection with the appropriate materials and tools.
- Identify several types of wire, and determine the current carrying capability of each.
- Given a section of wire, identify its voltage rating.
- Identify various lugs and connectors and state the application of each.
- Strip wire using the appropriate tool.
- Make electrical splices using appropriate tools and lugs.
- Properly tape an electrical connection.
- Locate a lighting panel and/or a power panel directory using the Intranet.
- Remove a circuit breaker from a lighting panel.
- Install a circuit breaker in a lighting panel.
- De-energize and energize a power panel disconnect and a local disconnect.
- Properly install/remove fuses from a power panel disconnect.
- Properly connect a receptacle and plug to a power cord.
- Make the proper connections to a duplex receptacle.
- Make the proper connections to a Ground-Fault Circuit-Interrupter (GFCI).
- Explain the operation of a single-pole, three-way, and four-way switch, and hook up combinations of each.
- Correctly hook up an incandescent light.
- Read and interpret an ampacity table.
- Explain grounding, identify proper grounds on electrical equipment, and identify improperly and properly grounded process equipment.
- Explain bonding and identify properly bonded process equipment.

Lab Hours: 12

Electrical Test Equipment
NSCC1008134

Lab Performance Objectives:

The following is a list of performance objectives for Electrical Test Equipment Lab.

- State the main purpose of a voltage tester.
- Identify the parts of a voltage tester.
- State the operating principle of a voltage tester.
- List the checks to be made to ensure a voltage tester is in good operating condition.
- List the warnings involved when using a voltage tester (page 1-2 of Instruction Manual ND-3401-1).
- List the cautions involved when using a voltage tester (page 2-3 of Instruction Manual ND-3401-1).
- Use a voltage tester to check an energized/de-energized AC circuit.
- Use a voltage tester to check an energized/de-energized DC circuit.

- Identify the features of an Ideal Split-Jaw Smart-Meter (#61-096).
- State the Safety Information instructions found on page 2 of the Ideal Industries, Inc. Instruction Card ND- 3410 that will ensure safe operation and service of the tester as well as the Caution and Warning located on page 3 and 4.
- State the three Priority of Function modes of the Split-Jaw Smart- Meter
- Use a Split-Jaw Smart-Meter to measure current, voltage, resistance, and continuity.
- State the purpose of a megohmmeter (Megger).
- Identify the parts and features of a typical megohmmeter (Megger).
- Test a megohmmeter to ensure proper operation.
- List safety precautions to be used when using a megohmmeter.
- List four factors that affect insulation resistance.
- Use a megohmmeter to test wiring insulation and motors.
- Identify the functions, function buttons, connections, switches, and display of a digital multimeter.
- Locate, check, and replace the battery and fuses of a digital multimeter (DMM).
- Use a digital multimeter (DMM):
    - Measure DC voltage
    - Measure DC current
    - Measure AC voltage
    - Measure resistance
    - Measure conductance
    - Test diodes

Lab Hours: 4

Electrical Drawings
NSCC10075C4

Lab Performance Objectives:

The following is a list of performance objectives for Electrical Drawings Lab.

- Identify symbols used in electrical elementary diagrams
- Recognize the difference between schematics and wiring diagrams
- Read electrical elementary diagrams
- Hook-up designed electrical elementary drawings on training simulator
- Given an electrical elementary drawing, revise the drawing according to specified instructions

Lab Hours: 8

Transformers & 3-Phase Electricity Fundamentals
NSCC1008133

Lab Performance Objectives:

The following is a list of performance objectives for Transformers & 3-Phase Electricity Fundamentals Lab.

- State how a transformer operates:
  - Calculate primary and secondary voltage
  - Calculate primary and secondary current
  - Properly connect a single phase transformer
  - Properly ground a single phase transformer
  - Distinguish single phase ac power from three phase ac power
  - Properly connect a three phase transformer
  - Properly ground a three phase transformer
  - Calculate transformer voltage for various three-phase systems

Lab Hours: 16

Conduit Installation
NSCC10083AA

Lab Performance Objectives:

The following is a list of performance objectives for the Conduit Installation Lab.

- Define conduit.
- State the function of conduit.
- Explain how conduit is sized.
- Identify rigid conduit
- Identify aluminum conduit.
- Identify vapor proof conduit (liquid tight).
- Use Engineering Standard ELECF01 A to determine the proper number of conductors allowed for a specific size of conduit.
- State the purpose of obround series of condulet fittings.
- Identify and state the use of "L" fittings.
- Identify and state the use of "C", "E", "T", "TA", "TB", and "X" obround fittings.
- State the purpose of "F" type series condulet fittings.
- Identify "FS" condulet fittings
- Identify "FD" condulet fittings
- State the purpose and identify the following explosion fittings: (GUAB, GUAC, GUAD,GUAM , GUAN,GUAT, GUAW, GUAX, ECGF, ECLK)

Upon successful completion of this module the trainee will be able to identify and state the function of:

- Junction boxes.

- Conduit bushings (male and female)
- Locknuts.
- Conduit couplings
- 90 degree elbows
- “EL” condulets
- “PLG” condulet plugs
- “RE” condulet reducer
- Jiffy plugs
- “UNF” conduit unions
- Conduit insulated bushings
- “UNJ” fixture hangers
- PC clamps
- RC clamp
- One hole clamps
- Two hole clamps
- Minerallac clamps
- Sealing fittings
- EYD sealing fittings
- EYS sealing fittings
- EZS sealing fittings:
    - Measure conduit
    - Define the "take-up distance" of hand benders
    - Define "back of the 90" measurement

Make a "90" bend in conduit

- Cut and thread conduit
- Make an offset bend in conduit
- Make a "kick" in conduit
- Make a "saddle" bend in conduit

Lab Hours: 16

Industrial Electricity: Basic AC Motor Controls
NSCC1008308

Lab Performance Objectives:

The following is a list of performance objectives for Industrial Electricity: Basic AC Motor Controls Lab.

- Describe the function of various types of control devices, including limit switches, flow switches, level/float switches, pressure switches, push button switches, and temperature switches.
- State the operating characteristics and applications of control relays
- State the operating characteristics of ON-delay timers.
- State the operating characteristics of OFF-delay timers.
- Describe the function and operation of various types of overload devices, including thermal and magnetic
- Identify symbols used on electrical schematics and wiring diagrams.
- Discuss and perform a lockout/tagout procedure.

- Identify the schematic symbols of control devices typically included in a basic motor control circuit.
- Identify the schematic symbols for manual starters as well as non-reversing and reversing magnetic starters.
- Identify the wire color code for motor control circuits.
- Read schematic diagrams of basic motor control circuits.
- Construct AC Motor Control circuits using various devices on the Lab-Volt Motor Controls Trainer.
- Determine the proper NEMA starter size using motor name-plate ratings.
- Determine the proper fuse size using motor name-plate ratings.
- Determine the required overload size using the motor name-plate ratings.
- Read and draw a basic motor control circuit for a single-phase motor with a manual starter.
- Read and draw basic motor control circuits for a non-reversing magnetic starter and a reversing magnetic starter using various pushbuttons, relays, limit switches, and other control devices.
- Correctly hook up a single-phase motor with a manual starter.
- Correctly hook up a three-phase non-reversing motor control circuit using various push-buttons, relays, limit switches, and other control devices.
- Correctly hook up a three-phase reversing motor control circuit.
- Given the appropriate test equipment, troubleshoot and repair various motor control circuits.
- Lock and tag a local disconnect.

Lab Hours: 24

AC/DC Motors
NSCC10042C7

Lab Performance Objectives:

The following is a list of performance objectives for AC/DC Motors Lab.

- Examine the construction of a DC motor.
- Measure the resistance of DC motor windings.
- Study the nominal current capabilities of various DC motor windings.
- Locate the neutral brush position on a DC motor.
- Learn basic motor wiring connections.
- Observe the operating characteristics of series and shunt connected motors.
- Study the torque vs. speed characteristics of a shunt wound, series wound, and compound wound DC motor.
- Calculate the efficiency of the shunt wound, series wound, and compound wound DC motor.
- Determine the counter-emf in a permanent magnet DC motor.
- Learn how to reverse the rotation on DC motors.
- Examine the construction of a split-phase motor and measure the resistance of its windings.
- Learn the basic motor wiring connections and observe the starting and running operation of the split-phase motor.
- Measure the starting and operating characteristics of the split-phase motor under load and no-load conditions, and study its power factor and efficiency.
- Measure the starting and operating characteristics of the capacitor-start motor, and compare its starting and running performance with the split-phase motor.
- Gain a basic understanding of Universal Motors.

- Learn how to reverse the rotation on single phase motors.
- Examine the construction of the three-phase squirrel-cage motor, and determine its starting, no-load, and full-load characteristics.
- Describe how three-phase motors start and run.
- Connect a dual-voltage three-phase motor.
- Megger a three-phase motor and associated power wiring.
- Measure three-phase motor current while varying the motor load.
- Troubleshoot a three-phase motor circuit using appropriate test equipment.
- Learn how to reverse the rotation on three-phase motors.

Lab Hours: 16

DC Fundamentals
NSCC1003F96

Lab Performance Objectives:

The following is a list of performance objectives for DC Fundamentals Lab.

- Demonstrate the ability to use Ohm's law with circuit measurements.
- Measure voltage, current, and resistance in a series circuit.
- Troubleshoot a series circuit and determine if a component is opened, shorted, or value has changed and identify that component. Demonstrate the ability to use Ohm's law with circuit measurements.
- Measure voltage, current, and resistance in parallel circuit.
- Troubleshoot a parallel circuit and determine if a component is opened, shorted, or value has changed and identify that component.
- Demonstrate the ability to use Ohm's law with circuit measurements.
- Measure voltage, current, and resistance in a series-parallel circuit.
- Troubleshoot a series-parallel circuit and determine if a component is opened, shorted, or value has changed and identify that component.
- Demonstrate the ability to use Ohm's law with circuit measurements.
- Measure voltages in unloaded and loaded voltage dividers circuits.
- Measure voltages drops in a bridge circuit and determine if the circuit is balanced or unbalanced.

Lab Hours: 24

AC Fundamentals
NSCC1003F98

Lab Performance Objectives:

The following is a list of performance objectives for AC Fundamentals Lab.

- Given an oscilloscope and a function generator, set up the oscilloscope to read the output (frequency

and amplitude) of the function generator.
- Explain the meaning of phase angle as it pertains to current lagging or leading voltage.
- Define capacitance and its unit of measure.
- Identify the schematic symbol for a capacitor.
- Explain what happens to capacitance when connected in series or parallel circuits.
- Define inductance and its unit of measure.
- Identify the schematic symbol for an inductor.
- Explain what happens to inductance when connected in series or parallel circuits.
- Given a RCL circuit: calculate apparent, active, and reactive power.
- Given an RC, RL, or RCL series circuit, identify an open component in the circuit.
- Given an RC, RL, or RCL series circuit, identify a shorted component in the circuit.
- Given an RC, RL, or RCL series circuit, identify a changed value component in the circuit.
- Given an RC, RL, or RCL parallel circuit, identify an open component in the circuit.
- Given an RC, RL, or RCL parallel circuit, identify a shorted component in the circuit.
- Given an RC, RL, or RCL parallel circuit, identify a changed value component in the circuit.
- Given an RC circuit and a multimeter, observe capacitor charging and discharging using the multimeter.
- Given an RC circuit, verify RC time constants by use of measurements.

Lab Hours: 32

Analog Circuits
NSCC100420E

Lab Performance Objectives:

The following is a list of performance objectives for Analog Circuits Lab.

- Recognize normal operation of a junction diode, limiter circuit, and a clamper circuit.
- Measure current through a junction diode.
- Observe and identify an open and shorted junction diode.
- Measure input/output waveform of a diode limiter and clamper circuits.
- Identify faulty limiter and clamper circuits and determine the faulty component.
- Correctly connect a LED for normal operation.
- Given a transistor amplifier circuit measure gain.
- Given a transistor circuit observe cutoff and saturation.
- Given a transistor circuit measure collector current with varying load resistor.
- Given a transistor circuit observe and measure input/output waveforms of a common emitter amplifier to determine normal operation.
- Given a power supply circuit identify normal operation of a full, half wave, and bridge rectifier circuit.
- Given a power supply predict and measure the voltage drop of a reverse biased zener diode.
- Given a power supply circuit recognize normal operation of a zener diode.
- Given a power supply circuit measure input/output voltages of a zener diode regulator and voltage regulator.
- Given a power supply circuit recognize normal operation of a zener diode regulator and a voltage regulator.
- Given a power supply circuit recognize that a zener diode voltage regulator and a voltage regulator circuit is faulted.
- Given a power supply circuit observe the effects of a faulted component in zener diode voltage

regulator circuit and a voltage regulator circuit.
- Recognize the normal operation and faulted operation of a UJT Oscillator circuit.
- Recognize the normal operation and faulted operation of an SCR trigger circuit.
- Measure waveform in a UJT Oscillator.
- Measure the gate and anode current in an SCR trigger operating circuit.
- Recognize the normal operation and faulted operation of a 555 Timer.
- Observe the effect of AC voltages with basic Diac operation.
- Observe the effect of DC voltages with basic Diac operation.
- Observe the effect of AC voltages with basic Traic operation.
- Observe the effect of DC voltages with a basic Traic operation.

Lab Hours: 32

Digital Circuits
NSCC1004625

Lab Performance Objectives:

The following is a list of performance objectives for Digital Circuits Lab.

- Measure input and output waveforms of an AND gate using a logic probe.
- Read the truth table for an AND gate.
- Measure input and output waveforms of an OR gate using a logic probe.
- Read the truth table for an OR gate.
- Measure input and output waveforms of a NOT gate using a logic probe.
- Read the truth table for a NOT gate.
- Measure input and output waveforms of an NAND gate using a logic probe.
- Read the truth table for an NAND gate.
- Measure input and output waveforms of a NOR gate using a logic probe.
- Read the truth table for a NOR gate.
- Measure input and output waveforms of a XOR gate using a logic probe.
- Read the truth table for a XOR gate.
- Measure input and output waveforms of a half-adder using a logic probe.
- Read the truth table for a half-adder gate.
- Measure input and output waveforms of a full adder using a logic probe.
- Read the truth table for a full adder.

Lab Hours: 16

Fundamentals of Problem Solving & Troubleshooting - Electrical
NSCC10083D2

Lab Performance Objectives:

The following is a list of performance objectives for Fundamentals of Problem Solving & Troubleshooting - Electrical.

- Follow a valid and reliable "Troubleshooting Process." The process can then be used to isolate malfunctions in most mechanical, electrical & instrument systems. Five major steps include:
    1. I.D. the Abnormality, Symptom or Fault
    2. Determine the Faulty Element or Component
    3. Plan a Course of Action
    4. Repair the Equipment
    5. Observe & Follow-up on Equipment Operation
- Practice and demonstrate learned skills in troubleshooting the five most common industrial motor control circuits. The 7100 ICST Trainer is used and has approximately 152 different instructor controlled faults.

Lab Hours: 24

Motor Drives
NSCC100E001

Lab Performance Objectives:

The following is a list of performance objectives for Motor Drives Lab.

- Use an AC Drive to control an Induction Motor
- Set the operating parameters of an AC Drive
- Protect the motor from overcurrent, overvoltage and overheating

Lab Hours: 16