

BRX 120 Basic Blueprint Reading 3 Credits

Description:

Includes basic applied math, lines, multiview drawings, symbols, various schematics and diagrams, dimensioning techniques, sectional views, auxiliary views, threads and fasteners, and sketching typical to all shop drawings. Emphasizes safety as an integral part of the course.

Components: Lecture: 3 credits (45 contact hours).

Competencies/Student Outcomes:

Upon completion of this course, the student can:

1. Use basic applied math and measurement tools to interpret drawings.
2. Use linetypes and other standard graphical symbols.
3. Identify and arrange single and multiview drawings.
4. Describe the principles and concepts of orthographic projection.
5. Describe the principles and concepts of sectional and auxiliary views.
6. Demonstrate proper sketching techniques.
7. Interpret dimensions on assembly drawings.
8. Demonstrate proper dimensioning techniques.
9. Apply and interpret tolerances.
10. Describe the concepts of detail and assembly drawings.
11. Describe drawing notes and title block information.
12. Identify machining specifications.

Outline:

- I. Print Reading Fundamentals
 - A. Mathematics review
 - B. Lettering
 - C. Reading the steel rule
 - D. Measurement tools
 - E. The alphabet of lines
 - F. Multiview drawings
 - G. Title block
 - H. Drawing change system
 - I. List of materials
- II. Drawing Views and Setup
 - A. Pictorial drawings
 - B. Sectional views
 - C. Auxiliary views
 - D. Detail and assembly drawings
 - E. Freehand sketching
 - F. Orthographic projection
- III. Dimensioning and Tolerances
 - A. Dimensions sizes and locations
 - B. Dimensioning of shop drawings
 - C. Specifications and callouts
 - D. Geometric dimensioning and tolerancing
 - E. Thread representation and specification

Description:

Provides the basic principles needed for a solid foundation in machine tool technology. Covers shop safety, bench work, drill press, power saw, measurement, and mills.

Components: Lecture: 1 credit hour (15 contact hours). Laboratory: 2 credit hours (60 contact hours).

Prerequisite: None

Competencies:

Upon completion of this course, students can:

1. Demonstrate and practice safe work habits in the lab area.
2. Perform bench work processes, hacksaw, files, layout, drill, tap and other activities to meet industry standards.
3. Perform safe and functional activities on the following machines: horizontal bandsaw, vertical bandsaw, drill press, arbor press, lathes, and mills.
4. Perform tasks with cutting hand tools and non-cutting hand tools.
5. Identify and explain the handling procedure for hazardous material and the content of MSDS.

Outline:

- I. Safety practices
 - A. General shop safety rules and regulations
 - B. Safe use of non-cutting hand tools
 - C. Safe use of cutting hand tools
 - D. Safe use of power saws
 - E. Safe use of drill press
 - F. Identification of all MSDS requirement information
- II. Benchwork
 - A. Performance of benchwork operations using bench tools
 - B. Safe operation of hand cutting tools
- III. Power equipment
 - A. Set-up and proper operation of power saws
 - B. Use of standard procedures for power saw operations
 - C. Set-up and proper operation of drill press
 - D. Use of feed and speed calculations to determine cutting rates on all power equipment.

Experiments/activities:

1. Prepare for a benchwork process.
2. Hand saw with a hacksaw.
3. Bench file the workpiece.
4. Dress and true grinding wheels on bench and pedestal grinders.
5. Demonstrate knowledge of power saws, parts and applications.
6. Demonstrate the care and safe use of the power saw.

7. Cut and weld bandsaw blades.
8. Perform operations on the cut-off saw.
9. Perform operations on the vertical bandsaw.
10. Demonstrate knowledge of drill press, parts and applications.
11. Demonstrate the care and safe use of the drill press.
12. Calculate and set the cutting speed and feed on the drill press.
13. Sharpen drills.
14. Set up a drill press and drill holes.
15. Shape and finish holes on a drill press.
16. Tap holes by hand and machine on a drill press.
17. Thread by hand with taps and dies.
18. Use chisels and punches.
19. Demonstrate knowledge of hazardous materials handling.
20. Demonstrate knowledge of hazardous materials storage.
21. Demonstrate lock-out/tag-out procedures.
22. Demonstrate use of MSDS.

EET 270 Electrical Motor Controls I 2 credits

Description:

Addresses the diversity of control devices and applications used in industry today. Emphasizes the importance of safety and electrical lockouts.

Components: Lecture 2 credits (30 contact hours)

Pre-requisites: (ELT 110 or EET 119) with a minimum grade of "C" or consent of Electrical Technology program advisor(s).

Co-requisite: EET 271

Implementation: Fall 2020

Task List:

1. Connect control relay systems
2. Connect dynamic braking circuit for AC motors
3. Connect dynamic braking circuit for DC motors
4. Test magnetic starters
5. Connect overload relays into starting control circuits
6. Connect potential type motor starting relays
7. Connect reduced voltage starters
8. Connect time delay relays
9. Connect motor for automatic controls
10. Connect automatic reduced voltage starter for DC motor control
11. Connect control relay systems
12. Connect limit switches
13. Connect motor control circuits for pluggings
14. Connect point starters for DC motors
15. Connect push button stations
16. Connect selector switches
17. Connect sensing devices (non-electric)
18. Connect magnetic starters

Learning Resources:

Dates of Actions:

Approved:

Revised: November 2019

EET 271 Electrical Motor Controls I Lab 2 credits

Description:

Provides practical experience in the use of control devices and their applications in industry today. Emphasizes the importance of safety and electrical lockouts.

Components: Laboratory 2 credits (60 contact hours)

Pre-Requisites: (ELT 110 or EET 119) with a minimum grade of "C" or consent of the Electrical Technology program advisor(s).

Co-requisites: EET 270

Implementation: Fall 2020

Competencies:

Upon completion of this course, the student can:

1. Connect control relay systems.
2. Connect dynamic braking circuit for AC motors.
3. Connect dynamic braking circuit for DC motors.
4. Test magnetic starters.
5. Connect overload relays into starting control circuits.
6. Connect potential type motor starting relays.
7. Connect reduced voltage starters.
8. Connect time delay relays.
9. Connect motor for automatic controls.
10. Connect automatic reduced voltage starter for DC motor control.
11. Connect limit switches.
12. Connect motor control circuits for plugging.
13. Connect point starters for DC motors.
14. Connect push button stations.
15. Connect selector switches.
16. Connect sensing devices (non-electric).
17. Connect magnetic starters.

Outline:

- I. Introduction
 - A. Safety
 - B. Review of NEC
- II. Connection
 - A. Control relay systems
 - B. Dynamic braking circuits for AC motors
 - C. Dynamic braking circuits for DC motors
 - D. Overload relays and starting control circuits
 - E. Motor starter relays
 - F. Reduced voltage starters
 - G. Time delay relays
 - H. Motor for automatic controls
 - I. Automatic reduced voltage starter for DC motor control
 - J. Limit switches
 - K. Motor control circuits for plugging
 - L. Point starters for DC motors
 - M. Push button stations

- N. Selector switches
- O. Sensing devices
- P. Magnetic starters
- III. Testing of Equipment
 - A. Starters
 - B. Switches

Experiments/Activities:

1. Connect control relay systems.
2. Connect dynamic braking circuit for AC motors.
3. Connect dynamic braking circuit for DC motors.
4. Test magnetic starters.
5. Connect overload relays into starting control circuits.
6. Connect potential type motor starting relays.
7. Connect reduced voltage starters.
8. Connect time delay relays.
9. Connect motor for automatic controls.
10. Connect automatic reduced voltage starter for DC motor control.
11. Connect limit switches.
12. Connect motor control circuits for plugging.
13. Connect point starters for DC motors.
14. Connect push button stations.
15. Connect selector switches.
16. Connect sensing devices (non-electric).
17. Connect magnetic starters.

Learning Resources:

Herman, S. (2004). *Delmar's standard textbook of electricity (3rd ed.)*. Albany, New York: Delmar Publishers

Kaiser, J. (1998). *Electrical power*. Tinley Park, Illinois: Goodheart-Willcox. Note: This text is currently used, as another edition is not yet available.

Herman, S. (1999). *Electrical transformers and rotating machines*. Albany, New York: Delmar Publishers. Note: This text is currently used, as another edition is not yet available.

Dates of Actions:

Approved: November 2019

Revised:

EET 272

Electrical Motor Controls II

2 credits

Description:

Introduces advanced study of motor controls in industry. Focuses on solid state relays, hall effect sensors, proximity detectors and photo detectors. Provides "hands-on" instruction to include sketching, installing, and troubleshooting the following; three phase controls, variable speed drives using relays as well as solid state devices. Provides an introduction to the installation and programming of Programmable Logic Controllers.

Components: Lecture: 2 credits (30 contact hours)

Pre-requisite: EET 270 OR EET 264 OR EET 268 with a minimum grade of "C" or consent of Electrical Technology program advisor(s).

Co-requisite: EET 273

Task List:

1. Plan an orderly shutdown procedure to conduct planned maintenance
2. Design and build control circuits utilizing electronic sensing devices
3. Design and build control circuit utilizing electronic output devices
4. Install drum switch for motor controls
5. Program a programmable logic controllers (PLC)
6. Install PLC to replace relay systems
7. Install PLC to operate fluid power systems
8. Install forward/reverse control for three-phase motors
9. Install inching, jogging control of three-phase motors

Learning Resources:

Dates of Actions:

Approved: November 2019

Revised:

EET 273

Electrical Motor Controls II Lab

2 credits

Description:

Provides hands-on experience in advanced studies in electrical controls used in industry including three-phase motor control and variable speed control using solid state devices and Programmable Logic Controllers.

Components: Laboratory: 2 credits (60 contact hours)

Pre-requisite: EET 271 OR EET 265 OR EET 269 with a minimum grade of "C" or consent of Electrical Technology program advisor(s).

Co-requisite: EET 272

Implementation: Fall 2020

Task List:

1. Plan an orderly shutdown procedure to conduct planned maintenance
2. Design and build control circuits utilizing electronic sensing devices
3. Design and build control circuit utilizing electronic output devices
4. Install drum switch for motor controls
5. Program a programmable logic controllers (PLC)
6. Install PLC to replace relay systems
7. Install PLC to operate fluid power systems
8. Install forward/reverse control for three-phase motors
9. Install inching, jogging control of three-phase motors

Learning Resources:

Dates of Actions:

Approved: November 2019

Revised:

EET 276

Programmable Logic Controllers

2 credits

Description:

Introduces principles and applications of Programmable Logic Controllers including installation, logic fundamentals, and numbering systems; basic programming of inputs, outputs, timers, and counters, comparators, basic data manipulation, and safety circuits of industrial Programmable Logic Controllers

Components: Lecture: 2 credits (30 contact hours)

Pre-requisites: EET 270 OR EET 268 OR EET 274 with a minimum grade of "C" or consent of Electrical Technology program advisor(s)

Co-requisites: EET 277

Implementation: Fall 2020

Competencies:

Upon completion of this course, the student can:

1. Define a Programmable Logic Controller (PLC) and list its advantages over relay systems.
2. Identify, list, and describe the function of the main parts of the hardware components used in PLC systems.
3. Outline the basic sequence of operation for a PLC.
4. Identify the general classifications of PLCs.
5. Describe the basic circuitry and applications for discrete and analog input and output (I/O) modules
6. Identify and interpret typical PLC I/O and CPU specifications.
7. Identify and explain PLC I/O addressing formats.
8. Describe the general classes and types of PLC memory.
9. List and describe different types of PLC peripheral support modules.
10. Define the decimal, binary, octal, and hexadecimal numbering systems and demonstrate conversion from one numbering system to another.
11. Perform basic addition, subtraction, multiplication, and division of binary numbers.
12. Define the terms bit, byte, word, least significant bit (LSB) and most significant bit (MSB) as they apply to binary memory locations.
13. Review common electromechanical symbols and devices and their implementation in I/O connectivity diagrams.
14. Program and run PLC ladder logic programs from electromechanical relay ladder logic programs.
15. Describe the binary concept and the function of AND, OR, and NOT gates.
16. Develop and run elementary programs based on logic gate functions.
17. Describe input and output image table files and types of data files as functions of the PLC memory map.
18. Describe and test the PLC program scan sequence for single and continuous scan.
19. Identify and use common operating modes found in PLCs.
20. Identify and program the internal relay and the LATCH/UNLATCH instruction functions.
21. Program the PLC utilizing symbol and comment functions.
22. Write and run PLC programs directly from a narrative description of a process control circuit.
23. Describe the PLC timer instruction and their instructional control bits also differentiating between non-retentive and retentive timers.
24. Program and run the control of outputs using various types of PLC timers and their instructional control bits.
25. Describe the PLC UP and DOWN counter instruction and their instructional control bits.
26. Program and run the control of outputs using various types PLC counter instructions and their instructional control bits.
27. Program and run the control of outputs applying combinations of counters and timers to control systems.
28. Describe the operating principle of a transitional or one-shot contact.
29. Program the operation of the master control reset (MCR) instruction and describe its use.
30. Describe the operations of the jump (JMP) and label (LBL) instructions.
31. Explain the function of subroutines.
32. Describe safety considerations built into PLCs and programmed into a PLC installation.

33. Define data manipulation and apply the move (MOV) instruction to accomplish this in a PLC program.
34. Define compare instructions and apply various comparator instructions to accomplish this in a PLC program.
35. Describe proper grounding practices and preventative maintenance tasks associated with PLC systems.
36. List and describe specific PLC troubleshooting procedures.
37. Plan an orderly shutdown for PLC managed equipment.

Outline:

- I. PLC's: An Overview
 - A. Principles of Operation
 - B. Parts of a PLC
 - C. PLC size and Application
- II. PLC Hardware Components
 - A. Discrete I/O modules
 - B. Analog I/O modules
 - C. Special I/O modules
 - D. I/O specifications
 - E. The CPU
 - F. Memory design and types
- III. Number Systems and Codes
 - A. Decimal System
 - B. Binary System
 - C. Octal System
 - D. Hexadecimal System
 - E. Binary Arithmetic
- IV. Fundamentals of Logic
 - A. The Binary Concept
 - B. AND, OR, NOT Functions
 - C. Boolean Algebra and Expressions
 - D. Producing PLC Ladder circuits from Logic Gates
- V. Basics of PLC Programming
 - A. Processor Memory Organization
 - B. Program Scan
 - C. Relay-Type Instructions
 - D. Instruction Addressing
 - E. Branch Instructions
 - F. Internal Relay Instructions
 - G. Programming EIO and EIC Instructions
 - H. Entering the Ladder Diagram
 - I. Modes of Operation
- VI. Developing PLC Wiring and Ladder Logic Diagrams
 - A. Examine Contactors, and Motor Starters as PLC Output Devices
 - B. Examine Manual, Mechanical, and Automatic Control as PLC Input Devices
 - C. Examine Pilot Lights, Control Relays, Solenoids, Heaters, Alarms, and Horns as PLC Output Devices
 - D. Examine Seal-In Circuits in PLC Programs
 - E. Latching Relays
 - F. Converting EMC Diagrams to PLC Ladder Diagrams
 - G. Writing PLC Ladder Diagrams from a Narrative
 - H. Safety Circuitry
- VII. Programming Timers
 - A. Timer Instructions
 - B. Non-Retentive On-Delay Timers
 - C. Non-Retentive Off-Delay Timers
 - D. Retentive Timers
 - E. Cascading Timers
- VIII. Data Manipulation Instructions
 - A. Data Transfer Operations (Move Instruction)

- B. Data Compare Instructions (Comparators)
- IX. Programming Counters
 - A. Counter Instructions
 - B. Up-Counter
 - C. Down-Counter
 - D. Cascading Counters
 - E. One-Shot (Transitional) Contact
 - F. Combining Counter and Timer Functions
- X. Program Control Instructions
 - A. Jump Instructions and Subroutines
 - B. Master Control and Zone Control Instructions
- XI. Troubleshooting Techniques
 - A. Grounding
 - B. Electrical Noise
 - C. Preventative Maintenance
 - D. PLC Shutdown Procedure

Learning resources:

Petruzella, F. D. (1998). *Programmable logic controllers (2nd ed.)*. New York: Glencoe McGraw-Hill

Note: This text is currently used and 3rd edition will be available Fall 2004

Rabiee, M. (2002). *Programmable logic controllers, hardware and programming*. Tinley Park, Illinois: Goodheart-Willcox

Dates of Actions:

Approved: November 2019

Revised:

EET 277
2 credits

Programmable Logic Controllers I Lab

Description:

Provides practical applications of programmable logic controllers including installation, logic fundamentals, and numbering systems; basic programming of inputs, outputs, timers, and counters, comparators, basic data manipulation, and safety circuits of industrial.

Components: Laboratory: 2 credits (60 contact hours)

Pre-requisites: EET 271 OR EET 269 OR EET 275 with a minimum grade of "C" or consent of Electrical Technology program advisor(s).

Co- requisites: EET 276

Implementation: Fall 2020

Competencies:

Upon completion of this course, the student can:

1. Define a Programmable Logic Controller (PLC) and list its advantages over relay systems.
2. Identify, list, and describe the function of the main parts of the hardware components used in PLC systems.
3. Outline the basic sequence of operation for a PLC.
4. Identify the general classifications of PLCs.
5. Describe the basic circuitry and applications for discrete and analog input and output (I/O) modules
6. Identify and interpret typical PLC I/O and CPU specifications.
7. Identify and explain PLC I/O addressing formats.
8. Describe the general classes and types of PLC memory.
9. List and describe different types of PLC peripheral support modules.
10. Define the decimal, binary, octal, and hexadecimal numbering systems and demonstrate conversion from one numbering system to another.
11. Perform basic addition, subtraction, multiplication, and division of binary numbers.
12. Define the terms bit, byte, word, least significant bit (LSB) and most significant bit (MSB) as they apply to binary memory locations.
13. Review common electromechanical symbols and devices and their implementation in I/O connectivity diagrams.
14. Program and run PLC ladder logic programs from electromechanical relay ladder logic programs.
15. Describe the binary concept and the function of AND, OR, and NOT gates.
16. Develop and run elementary programs based on logic gate functions.
17. Describe input and output image table files and types of data files as functions of the PLC memory map.
18. Describe and test the PLC program scan sequence for single and continuous scan.
19. Identify and use common operating modes found in PLCs.
20. Identify and program the internal relay and the LATCH/UNLATCH instruction functions.
21. Program the PLC utilizing symbol and comment functions.
22. Write and run PLC programs directly from a narrative description of a process control circuit.
23. Describe the PLC timer instruction and their instructional control bits also differentiating between a non-retentive and retentive timers.
24. Program and run the control of outputs using various types of PLC timers and their instructional control bits.
25. Describe the PLC UP and DOWN counter instruction and their instructional control bits.
26. Program and run the control of outputs using various types PLC counter instructions and their instructional control bits.
27. Program and run the control of outputs applying combinations of counters and timers to control systems.
28. Describe the operating principle of a transitional or one-shot contact.
29. Program the operation of the master control reset (MCR) instruction and describe its use.
30. Describe the operations of the jump (JMP) and label (LBL) instructions.
31. Explain the function of subroutines.
32. Describe safety considerations built into PLCs and programmed into a PLC installation.
33. Define data manipulation and apply the move (MOV) instruction to accomplish this in a PLC program.

34. Define compare instructions and apply various comparator instructions to accomplish this in a PLC program.
35. Describe proper grounding practices and preventative maintenance tasks associated with PLC systems.
36. List and describe specific PLC troubleshooting procedures.
37. Plan an orderly shutdown for PLC managed equipment.

Outline:

- I. PLC's Overview
 - A. Principles of Operation
 - B. Parts of a PLC
 - C. PLC size and Application
- II. PLC Hardware Components
 - A. Discrete I/O modules
 - B. Analog I/O modules
 - C. Special I/O modules
 - D. I/O specifications
 - E. The CPU
 - F. Memory design and types
- III. Number Systems and Codes
 - A. Decimal System
 - B. Binary System
 - C. Octal System
 - D. Hexadecimal System
 - E. Binary Arithmetic
- IV. Fundamentals of Logic
 - A. The Binary Concept
 - B. AND, OR, NOT Functions
 - C. Boolean Algebra and Expressions
 - D. Producing PLC Ladder circuits from Logic Gates
- V. Basics of PLC Programming
 - A. Processor Memory Organization
 - B. Program Scan
 - C. Relay-Type Instructions
 - D. Instruction Addressing
 - E. Branch Instructions
 - F. Internal Relay Instructions
 - G. Programming EIO and EIC Instructions
 - H. Entering the Ladder Diagram
 - I. Modes of Operation
- VI. Developing PLC Wiring and Ladder Logic Diagrams
 - A. Examine contactors, and motor starters as PLC Output devices
 - B. Examine manual, mechanical, and automatic control as PLC Input devices
 - C. Examine pilot lights, control relays, solenoids, heaters, alarms, and horns as PLC Output devices
 - D. Examine seal-in circuits in PLC programs
 - E. Latching Relays
 - F. Converting EMC Diagrams to PLC Ladder Diagrams
 - G. Writing PLC Ladder Diagrams from a Narrative
 - H. Safety Circuitry
- VII. Programming Timers
 - A. Timer Instructions
 - B. Non-Retentive On-Delay Timers
 - C. Non-Retentive Off-Delay Timers
 - D. Retentive Timers
 - E. Cascading Timers
- VIII. Data Manipulation Instructions
 - A. Data Transfer Operations (Move Instruction)
 - B. Data Compare Instructions (Comparators)
- IX. Programming Counters

- A. Counter Instructions
 - B. Up-Counter
 - C. Down-Counter
 - D. Cascading Counters
 - E. One-Shot (Transitional) Contact
 - F. Combining Counter and Timer Functions
- X. Program Control Instructions
- A. Jump Instructions and Subroutines
 - B. Master Control and Zone Control Instructions
- XI. Troubleshooting Techniques
- A. Grounding
 - B. Electrical Noise
 - C. Preventative Maintenance
 - D. PLC shutdown procedure

Experiments/activities:

- I. Unit 1 Lab - PLC's Overview
- A. Draw an I/O relay diagram, as specified by the instructor, on a sheet of paper and then enter the diagram in the PLC using the program mode using PLC ladder logic.
 - B. Place the PLC controller in the run mode and run the program.
 - C. Save the program and print it with your name and file title.
 - D. As specified by the instructor, modify the program and enter the modified program into memory.
 - E. Place the PLC controller in the run mode and run the program.
 - F. Save the program as a version of the previous file and print it with your name and renamed file title.
- II. Unit 2 – PLC Hardware Components
- A. Record specifications of the Input module for the type of PLC being used according to parameters set by the instructor.
 - B. Record specifications of the Output module for the type of PLC being used according to parameters set by the instructor.
 - C. Record specifications of the processor for the type of PLC being used according to parameters set by the instructor.
 - D. Document by diagramming the wiring of the PLCs input and output modules as connected to devices using proper labeling and drawing techniques.
 - E. Measure the amount of voltage and current of an input device such as a pushbutton when connected to the Input module when energized comparing your results to the specifications of the PLC.
 - F. Measure the amount of voltage and current of an output device such as a pilot light when connected to the Output module in the energized and deenergized states comparing your results to the specifications of the PLC.
 - G. Obtain a copy of a PLC program on a floppy disk from the instructor and copy it to the hard disk drive of the computer. Download the program from the hard disk drive to the PLC renaming the program. Run the program and save with a new title and your name on it to the hard disk drive. Copy the renamed program back to the floppy disk.
- III. Unit 3 – Numbering Systems and Codes
- A. Convert a set of binary numbers to decimal numbers as specified by the instructor.
 - B. Convert a set of decimal numbers to binary numbers as specified by the instructor.
 - C. Convert a set of octal numbers to decimal numbers as specified by the instructor.
 - D. Convert a set of hexadecimal numbers to decimal numbers as specified by the instructor.
 - E. Convert a set of hexadecimal numbers to binary numbers as specified by the instructor.
 - F. Add, subtract, multiply, divide binary numbers.
- IV. Unit 4 – Fundamentals of Logic
- A. Complete a truth table for a Boolean equation comprised of And, Or and Not logic functions. Create a PLC processor file that will run the program performing the equation correctly. Print this file using proper documentation.
 - B. Create a processor file using the PLCs AND, OR, NOT and XOR instructions. Use data supplied by the instructor for the instructions and run the program to verify the correct data is stored separate destination files for each logic function.

- V. Unit 5 – Basics of PLC Programming
 - A. Determine the proper I/O addressing format according to the type of PLC being used.
 - B. Determine the proper internal relays (Bit) addressing format according to the type of PLC being used.
 - C. Determine the scan time, branching, and word memory size according to the type of PLC being used.
 - D. Operate the PLC in the Program, Test, and Run modes utilizing EIO, EIC, and internal (Bit) relay instructions.
- VI. Unit 6 – Developing PLC Wiring and Ladder Logic Diagrams
 - A. Design, Program and Run a PLC processor file from a narrative where the file originates as an electromagnetic relay ladder logic and is converted to a PLC ladder logic. Safety considerations unique to the PLC file with regard to holding circuits are to be included.
 - B. Field connected I/O devices are to be used to operate the PLC processor file. The file is to have proper documentation for rung and instruction comments. The file is to be named and printed.
- VII. Unit 7 – Programming Timers
 - A. Create and run a processor file using the non-retentive On-delay (TON) and Off-delay (TOF) timer instructions.
 - B. Create and run a processor file using the retentive On-delay (RTO) timer instruction.
 - C. Create and run a variety of processor files that utilize timers in the following applications: repeat cycling, multiple on-delay, multiple off-delay, and one-shot operation.
- VIII. Unit 8 – Data Manipulation
 - A. Create and run a processor file where Comparator instructions such as: EQU, NEQ, GRT, LES, GEQ, LEQ are used.
 - B. Create and run a processor file utilizing the Move (MOV) instruction.
- IX. Unit 9 – Counter Applications
 - A. Create and run a processor file using Up (CU) and Down (CD) counter instructions.
 - B. Create and run a variety of processor files that utilize counters in the following applications: the sum of two counters, the difference between two counters, dividing a count by a timed interval to determine a rate, and counter applications using move, comparator, and timer instructions in an integrated process.
 - C. Create and run a processor file utilizing the one-shot (OSR) or transitional contact instruction.
- X. Unit 10 – Program Control Applications
 - A. Create and run a processor file where the Master Control Reset (MCR) or similar Zone Control (ZCL) instruction is used to establish a zone in the program for controlling all non-retentive outputs.
 - B. Create and run a processor file where the Jump to Label (JMP) (LBL) instructions are used to override portions of the program.
 - C. Create and run a processor file where the Jump to Subroutine (JSR) and Subroutine (SBR) and Return (RET) instructions are used to run a subroutine file from the main file.
- XI. Unit 11 – Troubleshooting
 - A. Write an orderly shutdown procedure for a PLC connected to an industrial process as determined by the instructor.
 - B. OSHA Lock-Out and Tag-Out policies need to be implemented for electrical, mechanical, and hydraulic circuits which are controlled by the PLC.

Learning resources:

Petruzella, F. D. (1998). *Activities manual for programmable logic controllers* (2nd ed.). New York: Glencoe McGraw-Hill

Note: This manual is currently used and 3rd edition will be available Fall 2004

Rabiee, M. (2002). *Laboratory manual programmable logic controllers, hardware and programming*. Tinley Park, Illinois: Goodheart-Willcox

Dates of Actions:

Approved: November 2019

Revised:

FPX 100 Fluid Power 3 Credits

Description:

Includes fluid power theory, component identification and application, schematic reading, and basic calculations related to pneumatic and hydraulic systems and their operations.

Components: Lecture: 3 credits (45 contact hours)

Co-requisite: FPX 101 or Consent.

Implementation: Spring 2010

Course Competencies/Student Outcomes:

Upon completion of this course, the student can:

1. Discuss safe working practices required for fluid power systems.
2. Discuss basic fluid power system applications.
3. Define basic fluid power terms, definitions, and physics.
4. Discuss pressure gauges and flow meters.
5. Convert from one pressure scale to another.
6. Interpret schematic symbols.
7. Discuss the principles of pump operation.
8. Discuss the principles of actuators.
9. Discuss the principles of fluid power system design.
10. Discuss the principles of hydraulic fluids and their applications.
11. Discuss the principles of reservoirs and breathers.
12. Discuss the principles of filters and their applications.
13. Discuss the principles of oil sampling techniques.
14. Discuss the principles of safe working practices used when performing routine maintenance of pneumatic systems.
15. Discuss basic working knowledge of the terms, definitions, and physics related to servicing compressed air and vacuum systems.
16. Discuss the principles of pneumatic systems.
17. Discuss the principles of air preparation.
18. Discuss the principles of air distribution systems and their installation and inspection.
19. Discuss the principles of basic compressor operation.
20. Discuss the principles of compressor servicing.
21. Discuss the principles of accumulators and intensifiers.
22. Discuss the principles of cylinder design and operation.
23. Discuss the principles of meter-in/meter-out/bleed off flow control circuits.
24. Discuss the principles of cylinder regeneration and sequencing.
25. Discuss the principles of check valves.
26. Discuss the principles of pilot-operated valve operation.
27. Discuss the principles of shutoff valve operation/ characteristics.
28. Discuss the principles of flow control types.
29. Discuss the principles of non-compensated and compensated flow controls.
30. Discuss the principles of two-way, three-way, and four-way valve operation.
31. Discuss the principles of solenoid operation and troubleshooting.
32. Discuss the principles of relief, sequence, unloading, braking, load control valve, and pressure reducing valve characteristics / symbols.
33. Discuss the principles of deceleration valve circuits.
34. Discuss the principles of pressure compensated pump operation.
35. Discuss the principles of hydraulic motor circuits.
36. Discuss the principles of compressor types (piston, screw, rotary and dynamic).
37. Discuss the principles of relief valves.

38. Discuss the principles of pressure regulation (relieving and non-relieving regulators).
39. Discuss the principles of flow control valves, silencers, and quick exhausts.
40. Discuss the principles and methods of directional control valve actuation.
41. Discuss the principles of pneumatic motor design and applications.
42. Discuss the principles of troubleshooting techniques.

Outline:

- I. Safe working practices
 - A. Lock out and tag out
 - B. MSDS
 - C. Right to know
 - D. Safe working practices required with fluid power and high pressure systems

- II. Introduction to fluid power
 - A. Applications
 - B. Basic terminology
 - C. Basic physics
 - D. Basic components
 - E. Basic system design and operation

- III. Introduction to maintaining hydraulic systems
 - A. Hydraulic fluid terms, definitions, and physics
 - B. Types of hydraulic fluids and their applications
 - C. Basic hydrodynamics
 - D. Types of filters and their applications
 - E. Reservoir and breather types and their applications

- IV. Maintaining hydraulic systems
 - A. Hydraulic conductor installation and inspection
 - B. Servicing hydraulic fluids
 - C. Routine preventive maintenance
 - D. Principles of oil analysis

- V. Introduction to maintaining pneumatic systems
 - A. Pneumatic terms, definitions, and physics
 - B. Pneumatic system applications
 - C. Air preparation
 - D. Basic compressors and air delivery systems
 - E. Basic driers, coolers, and receivers
 - F. Basic hydrodynamics

- VI. Maintaining pneumatic systems
 - A. Pneumatic conductor installation and inspection
 - B. Servicing air distribution systems
 - C. Servicing compressors, driers, and FLR's
 - D. Routine preventive maintenance

- VII. Actuator design and applications
 - A. Terms, definitions, and physics related to hydraulic components and systems
 - B. Cylinder designs and their applications
 - C. Hydraulic motor designs and their applications

- VIII. Pressure and flow control devices and their applications
 - A. Accumulators and intensifiers

- B. Check valves
 - C. Flow control valves
 - D. Pressure control valves
 - E. Directional control valves
- IX. Hydraulic circuits
- A. Schematic symbols
 - B. Circuit designs
 - C. Troubleshooting
- X. Actuator design and applications
- A. Terms, definitions, and physics related to pneumatic components and systems
 - B. Cylinder designs and their applications
 - C. Hydraulic motor designs and their applications
- XI. Pressure and flow control devices and their applications
- A. Accumulators and intensifiers
 - B. Check valves
 - C. Flow control valves
 - D. Pressure control valves
 - E. Directional control valves
- XII. Pneumatic circuits
- A. Schematic symbols
 - B. Circuit designs
 - C. Troubleshooting

Learning Resources:

Parr, A. (1999). *Hydraulics and pneumatics: A technician's and engineer's guide* (2nd ed.). Jordan Hill, Oxford/UK: Butterworth-Heinemann/Elsevier.

Doddannavar, R., Barnard, A., & Ganesh, J. (2005). *Practical hydraulic systems: Operation and troubleshooting for engineers and technicians*. Burlington, MA: Newnes.

Dates of Actions:

Approved:

Revised: November 2007, October 2009

Description:

Provides practical experiences in the study of fluid power theory, hydraulics and pneumatics component identification, schematic reading, and basic calculations related to hydraulic and pneumatic systems and their operations.

Components: Laboratory: 2 credit hours (60 contact hours).

Co-requisite: FPX 100 or Consent.

Implementation: Spring 2010

Competencies:

Upon completion of this course, the student can:

1. Demonstrate safe working practices required for fluid power systems.
2. Demonstrate a basic understanding of fluid power system applications.
3. Demonstrate a basic working knowledge of basic fluid power terms, definitions, and physics.
4. Demonstrate a working knowledge of pressure gauges and flow meters.
5. Demonstrate the ability to convert from one pressure scale to another.
6. Demonstrate a basic working knowledge of schematic symbols.
7. Demonstrate a basic working knowledge of pumps.
8. Demonstrate a basic working knowledge of actuators.
9. Demonstrate a basic working knowledge of fluid power system design.
10. Demonstrate a basic working knowledge of hydraulic fluids and their applications.
11. Demonstrate a basic working knowledge of reservoirs and breathers.
12. Demonstrate a basic working knowledge of filters and their applications.
13. Demonstrate a basic working knowledge of oil sampling techniques.
14. Demonstrate a necessary knowledge of the required safe working practices used when performing routine maintenance of pneumatic systems.
15. Demonstrate a basic working knowledge of the terms, definitions, and physics related to servicing compressed air and vacuum systems.
16. Demonstrate a basic working knowledge of pneumatic systems.
17. Demonstrate a basic working knowledge of air preparation.
18. Demonstrate a basic working knowledge of air distribution systems, their installation, and inspection.
19. Demonstrate a basic working knowledge of basic compressor operation.
20. Demonstrate a basic working knowledge of compressor servicing.
21. Demonstrate a basic working knowledge of accumulators and intensifiers.
22. Demonstrate a basic working knowledge of cylinder design and operation.
23. Demonstrate a basic working knowledge of meter-in/meter-out/bleed off flow control circuits.
24. Demonstrate a basic working knowledge of cylinder regeneration and sequencing.
25. Demonstrate a basic working knowledge of check valve operation and circuits.
26. Demonstrate a basic working knowledge of pilot-operated valve operation.
27. Demonstrate a basic working knowledge of shutoff valve operation/characteristics.
28. Demonstrate a basic working knowledge of flow control types.
29. Demonstrate a basic working knowledge of non-compensated & compensated flow controls.
30. Demonstrate a basic working knowledge of two-way, three-way, and four-way valve operation.
31. Demonstrate a basic working knowledge of solenoid operation and troubleshooting.
32. Demonstrate a basic working knowledge of relief, sequence, unloading, braking, load control valve, and pressure reducing valve characteristics / symbols.
33. Demonstrate a basic working knowledge of deceleration valve circuits.
34. Demonstrate a basic working knowledge of pressure compensated pump operation.
35. Demonstrate a basic working knowledge of hydraulic motor circuits.
36. Demonstrate a basic working knowledge of compressor types (piston, screw, rotary, and dynamic).
37. Demonstrate a basic working knowledge of relief valves.

38. Demonstrate a basic working knowledge of pressure regulation (relieving and non-relieving regulators).
39. Demonstrate a basic working knowledge of flow control valves, silencers, and quick exhausts.
40. Demonstrate a basic working knowledge of methods of directional control valve actuation.
41. Demonstrate a basic working knowledge of pneumatic motor design and applications.
42. Demonstrate a basic working knowledge of troubleshooting techniques.

Outline:

- I. Safe Working Practices
 - A. Lock out and Tag out
 - B. MSDS
 - C. Right to know
 - D. Safe working practices required with fluid power and high pressure systems
- II. Introduction to Fluid Power
 - A. Applications
 - B. Basic terminology
 - C. Basic physics
 - D. Basic components
 - E. Basic system design and operation
- III. Introduction to Maintaining Hydraulic Systems
 - A. Hydraulic fluid terms, definitions, and physics
 - B. Types of hydraulic fluids and their applications
 - C. Types of filters and their applications
 - D. Reservoir and breather types and their applications
- IV. Maintaining Hydraulic Systems
 - A. Hydraulic conductor installation and inspection
 - B. Servicing hydraulic fluids
 - C. Routine preventive maintenance
 - D. Principles of oil analysis
- V. Introduction to Maintaining Pneumatic Systems
 - A. Pneumatic terms, definitions, and physics
 - B. Pneumatic system applications
 - C. Air preparation
 - D. Basic compressors and air delivery systems
 - E. Basic driers, coolers, and receivers
- VI. Maintaining Pneumatic Systems
 - A. Pneumatic conductor installation and inspection
 - B. Servicing air distribution systems
 - C. Servicing compressors, driers, and FLRs
 - D. Routine preventive maintenance
- VII. Actuator Design and Applications
 - A. Terms, definitions, and physics related to hydraulic components and systems
 - B. Cylinder designs and their applications
 - C. Hydraulic motor designs and their applications
- VIII. Pressure and Flow Control Devices and Their Applications
 - A. Accumulators and intensifiers
 - B. Check valves
 - C. Flow control valves
 - D. Pressure control valves
 - E. Directional control valves
- IX. Hydraulic Circuits
 - A. Schematic symbols
 - B. Circuit designs
 - C. Troubleshooting
- XI. Pressure and Flow Control Devices and Their Applications
 - A. Accumulators and intensifiers
 - B. Check valves

- C. Flow control valves
 - D. Pressure control valves
 - E. Directional control valves
- XII. Pneumatic Circuits
- A. Schematic symbols
 - B. Circuit designs
 - C. Troubleshooting

Experiments/activities:

1. Demonstrate proper lock out tag out procedures.
2. Read the liquid level and temperature in the reservoir.
3. Service filters in hydraulic systems.
4. Operate a hydraulic power unit.
5. Connect and disconnect a hydraulic hose that uses quick-connect fittings.
6. Read a hydraulic pressure gauge and flow meter.
7. Adjust the pressure on hydraulic systems.
8. Read a pneumatic pressure gauge and flow meter.
9. Change filters in pneumatic systems.
10. Discuss pneumatic driers.
11. Service a lubricator.
12. Connect pneumatic compressors.
13. Safely start and stop a compressor.
14. Adjust the pressure on pneumatic systems.
15. Interpret a manometer.
16. Connect and set a pressure relief valve.
17. Connect hydraulic pumps.
18. Connect hydraulic actuators.
19. Draw a hydraulic schematic from the actual circuit connections on a pictorial.
20. Construct a simple hydraulic circuit.
21. Design and build a manually actuated DCV circuit.
22. Connect and operate a bi-directional hydraulic motor using a three-position, manually-operated DCV.
23. Connect two-way, three-way, and four-way valves (solenoid operated valves).
24. Construct and build a regeneration circuit.
25. Construct a meter-in and meter-out circuit.
26. Design and build a bleed off circuit.
27. Construct a accumulator circuit.
28. Discuss how a pressure booster (intensifier) circuit works.
29. Construct a synchronous cylinder circuit.
30. Construct a sequencing circuit.
31. Construct a pressure reducing valve circuit.
32. Construct a braking valve circuit with make up checks.
33. Construct a pilot-operated DCV circuit.
34. Construct a mechanically actuated DCV circuit.
35. Construct a clamp and drill circuit.
36. Disassemble, inspect, and reassemble cylinders and pumps.
37. Construct a quick exhaust circuit.
38. Discuss how a vacuum circuit works.

Learning resources:

Parr, A. (1999). *Hydraulics and pneumatics: A technician's and engineer's guide* (2nd ed.). Jordan Hill, Oxford/UK: Butterworth-Heinemann/Elsevier. *

Doddannavar, R., Barnard, A., & Ganesh, J. (2005). *Practical hydraulic systems: Operation and troubleshooting for engineers and technicians*. Burlington, MA: Newnes.

Dates of Actions:

Approved:

Revised: May 2004, October 2009

IMT 100**Welding for Maintenance****3 credits****Description:**

Provides basic instruction needed for student to weld using SMAW (Stick), GMAW (MIG), GTAW (TIG), and Oxy-Fuel processes.

Components: Lecture: 3 credits (45 contact hours)

Co-requisites: IMT 101 or Consent of Instructor

Implementation: Fall 2009

Competencies:

Upon completion of this course, the student can:

1. Explain welding safety.
2. Describe the selection, care, and storage of Oxy-Fuel cutting equipment.
3. Explain the Identification, selection, and storage of SMAW (stick welding) electrodes.
4. Apply principles of SMAW (stick welding) process to cutting welding metals.
5. Describe the set up and use of SMAW (stick welding) equipment.
6. Explain the application of basic metallurgy principles.
7. Explain the proper use of shop equipment and tools.
8. Explain the set up and use of GMAW (MIG) welders.
9. Explain the set up and use of GTAW (TIG) welders.

Outline:

- I. Introduction
 - A. Safety principles for welding
 - B. Shop equipment and tools
 - C. Principles of basic metallurgy
- II. SMAW Electrodes
 - A. Identification
 - B. Principles
 - C. Selection
 - D. Storage
- III. Welders
 - A. Set up
 1. SMAW
 2. Oxy-fuel cutting equipment
 3. MIG
 4. TIG
 - B. Use
 1. SMAW
 2. Oxy-fuel cutting equipment
 3. MIG
 4. TIG

Description:

Provides application of basic welding skills used in SMAW (Stick), GMAW (MIG), GTAW (TIG) and Oxy-Fuel.

Components: Laboratory: 2 credits (60 contact hours).

Co-requisites: IMT 100 or Consent of Instructor

Implementation: Fall 2009

Competencies:

Upon completion of this course, the student can:

1. Demonstrate welding safety.
2. Set up and cut with oxy-fuel cutting equipment.
3. Identify, select, and store SMAW electrodes.
4. Apply principles of SMAW process to cutting welding metals.
5. Set up and use SMAW welders.
6. Apply basic metallurgy principles.
7. Use shop equipment and tools.
8. Set up and use MIG welders.
9. Set up and use TIG welders.

Outline:

- I. Introduction
 - A. Safety principles for welding
 - B. Shop equipment and tools
 - C. Principles of basic metallurgy
- II. SMAW Electrodes
 - A. Identification
 - B. Principles
 - C. Selection
 - D. Storage
- III. Welders
 - A. Set up
 1. SMAW
 2. Oxy-fuel cutting equipment
 3. MIG
 4. TIG
 - B. Use
 1. SMAW
 2. Oxy-fuel cutting equipment
 3. MIG
 4. TIG

Experiments/activities:

1. Demonstrate welding safety.
2. Set up and cut with oxy-fuel cutting equipment.
3. Identify, select, and store SMAW electrodes.
4. Apply principles of SMAW process to cutting welding metals.
5. Set up and use SMAW welders.
6. Apply basic metallurgy principles.
7. Use shop equipment and tools.
8. Set up and use MIG welders.
9. Set up and use TIG welders.

Description:

This course introduces the theory of electricity and magnetism and the relationship of voltage, current, resistance, and power in electrical circuits. The course is designed to develop an understanding of alternating and direct current fundamentals. Students will apply formulas to analyze the operation of AC and DC circuits. Lecture.

Pre-requisites: None

TASK LIST

1. Apply shop and electrical safety practices
2. Identify and use basic hand tools
3. Care for and maintain hand tools
4. Solder/desolder electrical connections
5. Set up and operate power supplies
6. Compute, measure, and identify conductance and resistance of conductors and insulators
7. Measure properties of a circuit using VOM and DMM meters
8. Solve electrical circuit problems using Ohm's Law
9. Analyze, construct and troubleshoot parallel circuits
10. Analyze, construct and troubleshoot series circuits
11. Analyze, construct and troubleshoot series-parallel circuits
12. Determine physical and electrical characteristics of capacitors and inductors
13. Write technical reports
14. Use an oscilloscope to verify properties of an AC signal
15. Determine physical and electrical characteristics of transformers and test procedures
16. Compute and measure power in AC circuits
17. Apply and demonstrate the Edison system
18. Apply and demonstrate the three phase system
19. Analyze and identify circuit protection
20. Connect various transformer configuration
21. Wire two- and three-way switches
22. Wire single phase circuit

Description:

Verifies knowledge of basic theory by making measurements in working AC and DC circuits. Various types of circuits are constructed and their parameters measured. The use of test equipment, safety, and troubleshooting are stressed.

Laboratory: 2 credits (60 contact hours).

Co-requisites: IMT 110 or Consent of Instructor

Implementation: Fall 2004

Competencies:

Upon completion of this course, the student can:

1. Apply shop and electrical safety practices.
2. Identify and use basic hand tools.
3. Care for and maintain hand tools.
4. Solder/desolder electrical connections.
5. Set up and operate power supplies.
6. Compute, measure, and identify conductance and resistance of conductors and insulators.
7. Measure properties of a circuit using VOM and DMM meters.
8. Solve electrical circuit problems using Ohm's Law.
9. Analyze, construct and troubleshoot parallel circuits.
10. Analyze, construct and troubleshoot series circuits.
11. Analyze, construct and troubleshoot series-parallel circuits.
12. Analyze basic motors, generator theory and operation.
13. Write technical reports.
14. Use an oscilloscope to verify properties of an AC signal.
15. Determine physical and electrical characteristics of transformers and test procedures for transformers.
16. Compute and measure power in AC circuits.
17. Apply and demonstrate the Edison system.
18. Apply and demonstrate the three phase system.
19. Analyze and identify circuit protection.
20. Connect various transformer configurations.
21. Wire two- and three-way switches.
22. Wire single phase circuits.

Outline:

- I. Introduction
 - A. Safety
 - B. Test equipment
- II. DC Circuits
 - A. Ohm's law
 - B. Power formulas
 - C. Series circuits
 - D. Parallel circuits
 - E. Combination circuits
 - F. Magnetism
- III. AC Circuits
 - A. Inductance
 - B. Capacitance
 - C. Transformer basics

Experiments/activities:

1. Apply shop and electrical safety practices.
2. Identify and use basic hand tools.
3. Care for and maintain hand tools.
4. Solder/desolder electrical connection.
5. Set up and operate power supplies.
6. Compute, measure, and identify conductance and resistance of conductors and insulators.
7. Measure properties of a circuit using VOM and DMM meters.
8. Solve electrical circuit problems using Ohm's Law.
9. Analyze, construct and troubleshoot parallel circuits.
10. Analyze, construct and troubleshoot series circuits.
11. Analyze, construct and troubleshoot series-parallel circuits.
12. Determine physical and electrical characteristics of capacitors and inductors.
13. Write technical reports.
14. Use an oscilloscope to verify properties of AC signals.
15. Determine physical and electrical characteristics of transformers and test procedures.
16. Compute and measure power in AC circuits.
17. Apply and demonstrate the three phase system
18. Analyze and identify circuit protection.
19. Connect various transformer configurations.
20. Wire two-and three-way switches.
21. Wire single phase circuits.

Learning resources:

Brumbach, M. & Clade, J. (2003). *Industrial maintenance*. Albany, NY: Delmar Learning.

Kissell, T. (2001). *Motor control technology for industrial maintenance*. Upper Saddle River, NJ: Prentice Hall.

Dates of Actions:

Approved:

Revised: May 2004

Description:

Introduces the student to maintenance techniques and procedures used to maintain industrial equipment.

Lecture: 3 credits (45 contact hours).

Co-requisites: IMT 151 or Consent of Instructor

Competencies:

Upon completion of this course, the student can:

1. Describe the care and safe use of maintenance tools, equipment and components, e.g., lock-out/tag-out, rigging, electrical safety.
2. Describe lubrication techniques used on machines and components
3. Identify various types of bearings and seals.
4. Explain the replacement procedure for bearings and seals.
5. Explain alignment of couplings using, e.g., straight edge and feeler gauge, dial indicator methods, and laser.
6. Explain the mounting and operation of centrifugal pumps and motors.
7. Explain the mounting and operation of speed reduction/speed increase assemblies.
8. Explain the mounting and operation of clutch and brake assemblies.
9. Identify common belts, e.g., V-Belt, timing.
10. Explain the tensioning and alignment of various belts.
11. Identify common types chains, e.g., roller, silent.
12. Explain the tensioning and alignment of various chains.
13. Explain the alignment of sprockets and sheaves.
14. Explain the installation and adjustment variable of pitch sheaves.
15. Explain the common types of gears, e.g., spur, helical.
16. Describe the maintenance of open and closed gearing.
17. Explain the diametral pitch and gear meshing.
18. Explain vibration analysis in troubleshooting.
19. Identify various fasteners, key and keyways, and bolts.

Outline:

- I. Maintenance Tools, Equipment, and Components
 - A. Care of
 - B. Safety
 - C. Common belts
 - D. Common types chains
 - E. Common types gears
 - F. Fasteners, key and keyways, and bolts
- II. Maintenance Functions
 - A. Bearings and seals
 - B. Couplings
 - C. Centrifugal pumps and motors
 - D. Clutch and brake assemblies
 - E. Sprockets and sheaves
 - F. Open and closed gears
 - G. Vibration analysis

Description:

Provides the student with lab experience in the maintenance of industrial equipment.

Laboratory: 2 credits (60 contact hours).

Co-requisites: IMT 150 or Consent of Instructor

+Competencies:

Upon completion of this course, the student can:

1. Use maintenance tools, equipment and components safely, e.g., lock-out/tag-out, rigging, electrical safety.
2. Perform lubrication techniques on machines and components.
3. Replace bearings and seals.
4. Align couplings using, e.g., straight edge and feeler gauge, dial indicator methods, and laser.
5. Mount and operate centrifugal pumps and motors.
6. Mount and operate speed reduction/speed increase assemblies.
7. Mount and operate clutch and brake assemblies.
8. Adjust tension and alignment of various belts.
9. Adjust tension and alignment of various chains.
10. Align sprockets and sheaves.
11. Install and adjust pitch sheaves.
12. Maintain open and closed gearing.
13. Use vibration analysis in troubleshooting.

Outline:

- I. Maintenance Tools, Equipment, and Components
 - A. Care of
 - B. Safety
 - C. Common belts
 - D. Common types chains
 - E. Common types gears
 - F. Fasteners, key and keyways, and bolts
- II. Maintenance Functions
 - A. Bearings and seals
 - B. Couplings
 - C. Centrifugal pumps and motors
 - D. Clutch and brake assemblies
 - E. Sprockets and sheaves
 - F. Open and closed gears
 - G. Vibration analysis

Experiments/activities:

1. Use maintenance tools, equipment and components safely, e.g., lock-out/tag-out, rigging, electrical safety.
2. Perform lubrication techniques on machines and components.
3. Replace bearings and seals.
4. Align couplings using, e.g., straight edge and feeler gauge, dial indicator methods, and laser.
5. Mount and operate centrifugal pumps and motors.
6. Mount and operate speed reduction/speed increase assemblies.
7. Mount and operate clutch and brake assemblies.
8. Adjust tension and alignment of various belts.
9. Adjust tension and alignment of various chains.
10. Align sprockets and sheaves.
11. Install and adjust pitch sheaves.
12. Maintain open and closed gearing.
13. Use vibration analysis in troubleshooting.

IMT 200 Industrial Robotics and Robotic Maintenance 4 credits

Description:

Provides the industrial maintenance student an introduction to the theory of robots including applications, basic programming, components, industrial robotic safety standards, industrial robots classifications, key programming techniques, robotic motion concepts, and terminology. Instructs students on the concepts of preventive and predictive maintenance techniques required for a robot and their backup systems and recovery procedures. Provides the opportunity for the industrial maintenance student to develop, set up, and integrate work cells into manufacturing systems at a beginning level. Lecture, Laboratory.

Integrated Components: Lecture: 2 credit hours (30 contact hours). Laboratory: 2 credit hours (60 contact hours).

Pre-requisite: IMT 110 and IMT 111 or Consent of Instructor.

Implementation: Fall 2013

Competencies:

Upon completion of this course, the student can:

1. Display an understanding of the principles of robot safety.
2. Define a robot and explain the laws of robotics.
3. Define kinematics and explain the motion characteristics of a robotic coordinate system.
4. Demonstrate knowledge of robot terminology.
5. Describe the history of industrial robots and list common applications.
6. Demonstrate the ability to upload and download programs.
7. Describe how to open and execute existing robotic files.
8. Describe the procedure used to reset robot after E-stop or fault condition.
9. Operate a teach pendant.
10. Define the basic classifications of industrial robots and basic components within a robotic system.
11. Demonstrate the knowledge of servo and non-servo motor operation.
12. Describe positioning in terms of axis, actuators, and coordinate system relative to robotic control.
13. Identify robot power drive types.
14. Describe the operation of various sensors used in robot control.
15. Identify and describe the functions of vision systems.
16. Identify the work envelopes.
17. Perform mechanical installation, identification, and repair of servo and non-servo robots.
18. Describe the importance of back-up systems and replacing backup batteries on robotics equipment.
19. Explain and perform preventative maintenance.

Outline:

- I. Principles of Robotics
 - A. Introduction to Industrial Robotics
 - B. Fundamentals of Robotics
 - C. Programming the Robot
 - D. Industrial Applications
- II. Power Supplies and Movement Systems
 - A. Electromechanical Systems
 - B. Fluid Power Systems
- III. Sensing and End-of-Arm Tooling
 - A. Sensors
 - B. End Effectors
- IV. Control Systems and Maintenance
 - A. Computer Systems and Digital Electronics

- B. Interfacing and Vision Systems
- C. Maintaining Robotic Systems
- D. Robots in Modern Manufacturing
- E. The Future of Robotics

Experiments/Activities:

1. Identify safety devices and safeguards in a robot cell.
2. Identify basic components of a robot controller.
3. Identify the wiring of electrical switches, their purpose, and operation for the robot controller.
4. Identify the basic functions of a robot teach pendant.
5. Perform the operation and start up of a robot controller.
6. Use a teach pendant to manipulate a robot along its common axes.
7. Demonstrate the ability to program instructions.
8. Demonstrate a working knowledge of common robot modes.
9. Demonstrate an ability to use end effectors to perform a typical robot task as it relates to digital inputs and outputs.
10. Demonstrate robot positioning with regard to start up, coordinate systems and motion systems.
11. Demonstrate file manipulation.
12. Demonstrate mastering a backup system for robotics equipment.
13. Perform preventive maintenance and maintenance lubrication.
14. Locate and interpret error codes related to specific robot malfunctions.
15. Demonstrate the ability to return the robot safely to functional state, using error codes to diagnose error.
16. Demonstrate the ability to perform a general robot error recovery procedure using an appropriate troubleshooting method.
17. Locate the sections of a robot program that are involved in program initiation.
18. Locate and describe the portion of a robot program that is used to control a material handling end effector.

Learning resources:

- Ross, Larry (2011) *Robotics: Theory and industrial application* (2nd ed.). Tinley Park, IL: Goodheart-Wilcox
- FANUC Robotics. (2012) *Operations & programming elearn training*. Rochester Hills, MI: FANUC Robotics America.
- FANUC Robotics. (2012) *Robot preventative maintenance lubrication*. Rochester Hills, MI: FANUC Robotics America.

Dates of Actions:

Approved: March 2013