A. Course Description

- Credits: 6.00
- Lecture Hours/Week: 0.00
- Lab Hours/Week: 6.00
- OJT Hours/Week: 0
- Prerequisites:
  - ELEC 1120: A.C. Electricity Theory and Lab
  - ELEC 1130: National Electrical Code I
  - ELEC 1240: Construction Skills and Introduction to Wiring Lab

- Corequisites: None
- MnTC Goals: None

This course will consist of clearly directed lab exercises with the expectation of exact results, performance evaluations and related assignments. Students will have an opportunity to connect, troubleshoot, and operate both basic and complex control circuits, connect and operate single-phase and three-phase motors, across-the-line motor controllers, reduced-voltage starters, and variable frequency drives. In addition, students will connect and operate single-phase and three-phase transformers, autotransformers, and other electrical equipment and apparatus. The supporting technical information will be provided through a parallel theory course. Pre-requisites: ELEC 1240, ELEC 1120, ELEC 1130

B. Course Effective Dates: 1/13/03 – Present

C. Outline of Major Content Areas

As noted on course syllabus

D. Learning Outcomes

1. Calculate primary and secondary overcurrent protection.
2. Calculate the minimum ampacity of motor branch-circuit conductors.
3. Calculate the overcurrent protection for transformers
4. Calculate the values of voltage and current in a single-phase transformer.
5. Calculate voltage, current, and kVA ratings of transformers.
6. Connect and operate a VFD to control the speed of a three-phase, alternating-current motor from the integral keypad.
7. Connect and operate a VFD to control the speed of a three-phase, alternating-current motor using remote control circuits and speed references.
8. Connect and operate a part winding starter.
9. Connect and operate a single-phase motor for both the lower and higher nameplate voltage.
10. Connect and operate a solid-state controller to operate a three-phase motor.
12. Connect and operate a three-phase motor for the high-voltage connection.
13. Connect and operate a three-phase motor for the low-voltage and high-voltage connection.
14. Connect and operate a wye-delta starter.
15. Connect and operate an autotransformer in bucking and boosting applications.
17. Connect the primary and secondary windings for applicable voltages.
18. Connect transformer banks in wye and delta configurations.
20. Define terminology associated with VFDs.
21. Define the basic terminology and abbreviations associated with blueprints and print reading.
22. Demonstrate how to isolate energy sources.
23. Demonstrate organized and effective troubleshooting procedures while determining actual problems with power and control circuits and electrical apparatus.
24. Demonstrate organized and effective troubleshooting procedures while determining actual problems with single-phase and three-phase electric motors.
25. Describe control applications where proximity sensors and photoswitches are used rather than mechanically operated switches.
26. Describe the application, and the rules for using step ladders, straight ladders, scaffolding, and common hand and power tools.
27. Describe the construction and operating of various types of fuses and inverse-time circuit breakers.
28. Describe the construction of switchboards and panelboards.
29. Describe the information provided in a typical schematic diagram.
30. Describe the mission of OSHA related to construction sites.
31. Describe the operation of a single-phase motor and identify the parts of a single-phase, capacitor-start motor.
32. Describe the operation of a transformer.
33. Describe the operation of various types of reduced voltage controllers.
34. Describe the use of a voltmeter, ammeter, and ohmmeter to troubleshoot electrical systems.
35. Describe the use of a voltmeter, ammeter, ohmmeter, and insulation tester to troubleshoot electric motors.
36. Describe troubleshooting procedures for various types of motors.
37. Describe typical causes of motor failures and preventative measures.
38. Detail the NEC requirements for ground-fault circuit interrupter (GFCI) relating to the use of temporary power.
39. Determine buck-boost transformers ratings based on specific applications.
40. Determine the expected and measured voltages at varying points on a control circuit.
41. Diagram the connections for wye-connected and delta-connected motor windings for both the high and low voltage connections.
42. Diagram the power and control circuits of a part winding starter.
43. Diagram the power circuit of a wye-delta starter.
44. Discuss the different types of transformers.
45. Discuss the power and control circuits of an autotransformer starter.
46. Draw and connect a schematic diagram of a 3-wire motor control circuit with multiple start and stop buttons.
47. Draw and connect control circuit schematic diagrams using various interlocking techniques.
48. Draw schematic diagrams of simple control circuits.
49. Draw schematic diagrams using relays to control pilot lights based on a narrative description.
50. Draw the high- and low-voltage connections of a transformer.
51. Draw the schematic diagram, connect and operate a jogging control circuit.
52. Explain different methods of controlling the output frequency of a VFD.
53. Explain grounding requirements of transformer secondaries.
54. Explain the NEC requirements of a qualified person and arc flash protection.
55. Explain the basic operation of a VFD.
56. Explain the basic operation of the common timing relays and describe the operation of timed contacts.
57. Explain the characteristics of wye- and delta-connected three-phase systems.
58. Explain the difference between a relay, contractor and a motor starter.
59. Explain the operation of a transformer, including voltage, current and turns ratios.
60. Explain the operation of push button and selector switches.
61. Explain the recommended safe work practices for preventing accidental contact with energized equipment.
62. Explain the requirements for tightening terminations to a specific torque.
63. Explain the symptoms and effects of electrical shock.
64. Identify commonly used electrical personal protective equipment (PPE).
65. Identify situations where accidents are most likely to occur.
66. Identify the basic personal safety requirements associated with troubleshooting electrical equipment.
67. Identify the principles of overcurrent protection.
68. Interpret a schematic diagram of a control circuit of a motor control center unit.
69. Interpret the information found on a Material Safety Data Sheet (MSDS).
70. List the principle uses of control relays and describe their operation.
71. Navigate a construction print to obtain specific information regarding the types and placement of apparatus and equipment.
72. Use manufacture’s shop drawings to layout service entrance and feeder conduits for a switchboard installation.
73. Use manufacturer’s instructions and shop drawings to determine torque requirements for conductor connections demonstrating the proper use of a torque wrench.

E. Minnesota Transfer Curriculum Goal Area(s) and Competencies
F. Learner Outcomes Assessment
   As noted on course syllabus

G. Special Information
   None noted